THE GLASS INDUSTRY

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BOMB AT BIKINI

A modern navy relies heavily upon the products of the glass manufacturing industry. Many of the instruments by which it navigates, sights its guns, depend upon optical glass; the approved material for battleship insulation is fiber glass; portholes are sealed with heavy plate; illumination requires the glass light bulb; medicines are packaged and stored in glass containers. Although the battleship is preponderantly a ship of steel, glass it is which gives vitality to its complex mechanism, directs its functions, makes it effective as a weapon of war.

All these objects made from glass, and many more than we have cataloged, are fairly certain to be affected in some degree by the destructive forces released by the atom bomb. And it is to observe the nature and extent of these effects that THE GLASS INDUSTRY is sending its observers to the scene.

In reporting the glass phase of the atomic bombing to our readers, we face serious obstacles; in fact, we embark upon the project with no confidence that we will be able to report them at all. We know in advance that certain results of the test will be shrouded in the blanket of "security"; every observer is pledged not to write about these matters. Unfortunately, from our readers' standpoint, many of the most interesting "secrets" relate to glass. Other phenomena upon which we would like to report will require laboratory tests and months of time to evaluate. Admittedly we go to Bikini with more hope than assurance.

THE GLASS INDUSTRY's observer for the first test, tentatively scheduled for June 30, is John Ogden. Replacing him for the second test, perhaps three weeks later, will be Frank W. Preston. Here again, in replacing our observers, we need to be blessed with more than a normal degree of good luck; for until test one is completed, no schedule will be set up for test two. Dr. Preston's long trip from Pennsylvania to Bikini Atoll cannot be planned or arranged in advance.

These lines are written in mid-Pacific; at Pearl Harbor, en route to test one. Your correspondent is aboard the U.S.S. Appalachian, the most modern of the Navy's command vessels and serving as Press Ship for this expedition. Some hundred and fifty correspondents represent news, radio, magazine, television and photographic services. With only this handful to report to the entire world, the most important rendezvous in history, each one of us feels his individual responsibility keenly.

The Navy has provided every conceivable facility to make our job a success. Experts in the related fields of science are here for consultation. They lecture to us on atomic energy, the biochemistry of the sea, wild life in the Pacific, meteorolgy, on many subjects. We are shown documentary films of the War in the Pacific, partly for entertainment, partly as a job of orientation. We have maps and relief models of the Atoll, and later will receive a thorough briefing on the plans and preparations at Bikini, before we inspect the layout personally. We are tied in by radio to other ships, and they also will report their observations to us. We are equipped with television, with radar, which on "Able Day" will be focused on the Atoll. These things but suggest the elaborate preparations, the perfection of detail. Quoting Dr. R. E. Sawyer, Technical Director of Operation Crossroads: "There never was a single experiment in all history, where so many different kinds of things were measured at one time, with so many instruments. . . . This is perhaps the most complicated laboratory set-up ever undertaken."

The tentative schedule for the first bomb drop unfortunately coincides with our press deadline. Actually, meteorological conditions will determine the day and the hour, or may prevent the first drop from occurring at all. This news story of the test our readers will obtain through their radios and morning papers. Some hours later the Appalachian will enter the atoll to inspect the damage. At that time, if we have not passed our deadline, we will radio a brief summary of the glass phases of the test to editor Delgado. Should our deadline not permit this, Frank Preston will take over and his report on the second bomb test will appear in a later issue.

REHEARSAL FOR DOOMSDAY

(The Big Bad Bombs of Bikini)

By FRANK W. PRESTON

The present heavens and earth are reserved for destruction by fire.

II Peter 3: 7.

The heavens will pass away with a great noise, and the elements melt with the terrific heat: the earth and the works of man therein shall be burned up.

II Peter 3: 10.

These are melted into air, into thin air: the cloud-capped towers, the gorgeous palaces,
The solemn temples, the great globe itself
Yea, all which it inherit, shall dissolve
And . . leave not a wrack behind.

Shakespeare: The Tempest: IV. I.

Man is mortal, and knows that he is mortal. This is the bitter fruit of the tree of knowledge that drove man out of Eden: he found himself naked and defenseless in the presence of death. The shadow of death has hung over him ever since, and the consciousness of that shadow—a consciousness not shared by any other creature—is what makes him man.

All civilizations are based ultimately on the realization of this mortality: it permeates all their thinking and all their imagery. It is the stimulus of their best poetry, their best drama, and most of their other arts: above all it is the basis of their religions and their cosmogonies. It passes below the threshold of consciousness, and colors and dominates all our activities, including those in which the thought of death is seemingly far from us.

Spengler is probably correct in his brief categorical assertion[1] that all modern science is no more than a dissection of the pre-existing religious beliefs of the western world. It may seem a far cry from the dispassionate study of some utilitarian technological problem, such as the behavior of molten glass in its furnace, to the basic tenets of the Jewish and Christian theologies; but historically the connection is there, and it is not remote psychologically.

In the Arabian and Western World at least, the imminence of personal death is much mixed up with ideas about the end of the physical world and of the human race in its entirety. So far as the individual is concerned, the physical world comes to an end when he ceases to have any knowledge of it, that is, at his own death. Thus in one deep religious sense, death is the end of the world. But Western civilization, and the adjoining civilization of the Near East, have never been satisfied to identify themselves with the universe in that fashion. For us, the universe is something external, that persists independently of us; but since we are mortal, the universe must be mortal too, for we see it in our own likeness; and so the End of the Earth has engrossed the thoughts and imaginations of all generations.

According to Moses and his tutors, it nearly came about once by water, in Noah's heavy rainfall. Moses promised that it would not come that way again, and by the time of the early Roman Empire, the Near East had satisfied itself that it would come by fire. Peter and John are agreed on the point, and so is Paul, and virtually all the poets and dramatists of later years have concurred.

Now enters sceptical science, prepared circumspectly to dissect the accepted religious beliefs of the Western World. The second law of thermodynamics, applied on a cosmic scale (whereon it becomes little more than surmise or speculation), seems to guarantee that the universe must ultimately perish not of heat, but of cold. Everything is finally going to be at the same temperature, and that temperature is going to be very close to absolute zero, which is much worse even than a Western Pennsylvania winter.

This scientific "belief" was certainly the orthodox scientific view towards the end of the nineteenth century, and probably it still is, though it may not be held with quite so firm a conviction. It had its psychological advantages in emphasizing the difference of opinion between science and religion. Peter said categorically that the world was going to perish in a terrific fire: Kelvin and his contemporaries proved that logically the universe must perish by refrigeration.

Of course, while this destiny was inevitable for the universe as a whole, it might not be the destiny of that insignificant tiny speck that is our planet. It might be possible to vaporize the earth at an early date, while still leaving the universe to "run down hill" to thermodynamic zero. The earth might be roasted to a crisp or a vapor, for instance, if the sun became a nova, or if another star came sailing into collision with it, or if an oversized meteor crashed into the earth itself. There might be other simple astronomical setups to save Peter's face without in any way discrediting Kelvin.

But on one point the fathers of the church and the children of science were agreed without knowing it: man wasn't going to have any say in the matter. To Peter and his followers it was going to be a supernatural event, a direct intervention of the deity. To the physicists and astronomers it was going to be a purely natural event, the blind operation of the forces of nature. None of them figured on the possibility that it was going to be a purely artificial event, financed by the U. S. government.

Suggestions have been made that the rehearsal might turn into the big event itself: some have feared that the chain reaction, intended to be confined to the material of the bomb itself, might spread to the water of the ocean or the gases of the atmosphere. This possibility the best authorities deny. Others suggest that the concussion may

[1]Oswald Spengler: The Decline of the West. Alfred A. Knofp, New York.

set off an earthquake, and split the earth's crust with a great rift valley, miles deep and a few feet wide. This in turn would expose some of the earth's interior heat to the waters of the ocean, and generate a lot of steam in a hurry. But earthquakes have happened before, and the world has not been burnt to a crisp.

The danger most generally apprehended lies not in the physics of the rehearsal but in the psychological aspects. Small boys like to destroy things: show them how, or let them accidentally find out how, and they will enjoy themselves thoroughly in exploiting their knowledge. A large part of the human race are overgrown small boys.

Men have been destroying their environment ever since they have been men; they decimate or exterminate the wild-life, cut down or burn the forests, wear out the soil or wash it down the rivers or bury it by strip-mining, turn the streams into sewage, turn the blue-sky black with smoke, foul the seas with oil or radio-active by-products, and raise Cain generally; and he who does the most damage excites the greatest popular admiration.

Now comes nuclear energy to our hand, and all the devastations of the Mongols or the Nazis can be outdistanced by any swaggering swashbuckler with a few atoms at his disposal. Cities can be wiped out at a cost of a few dollars ("few," that is, as New Dealers reckon dollars) and there is reason to hope the price can be substantially reduced in the future. We have not yet reached the point of being able to wipe out the countryside also at an economical figure, but that is because countryside is cheap. It is, however, not beyond belief that further knowledge of nuclear physics may permit us to wipe out uninhabited forest, swamp, or desert at a modest cost, and perhaps thus to sear to the state of a lunar landscape whole countries or even continents. It will be sad to see harmless creatures like hyaenas and crocodiles going the same way as professors and the dwellers in large cities, but we have to face that possibility.

Once we understand thoroughly the way nuclear energy works, we may find that our powers of destruction extend beyond our own planet. We may be able to tinker with the nuclear processes going on in the sun, for instance. It would not require much stoking of the solar fires to raise the temperature of the earth's surface another 20°C. If this were done for a couple of weeks at midsummer, most of the earth's population would be dead of heat-stroke and whole continents burnt to a lifeless waste. Surely that is not too much to hope for, in some distant war. It would not be sufficient to fulfill Peter's prophecy of the elements themselves melting with fervent heat, but it might be sufficient to bring the human race to an end.

Such a roasting, done thoroughly, and perhaps kept up for six months so as to catch both northern and southern hemispheres, would destroy all life, vegetable and animal, on dry land, and probably most of that in the seas. We might be left with some such fauna as we had five hundred million years ago at the beginning of the Cambrian. Then evolution can start from scratch and may perhaps do a better job the next time.

This will not satisfy the he-men. They will demand no half-measures. Gentle grillings are not for them. They will demand the kind of roasting that Peter foresaw, the planet vanishing in thin air as Shakespeare prophesied. It may become possible to satisfy them.

CORRECTION FACTOR FOR SURFACE TENSION OF GLASS BY DROP-WEIGHT METHOD

By A. D. PRATER and A. E. BADGER

The drop-weight method of measuring the surface tension of glass as described by Tillotson[1] is the most convenient method of measuring this property. Although the precision of measurement is satisfactory for control work, the absolute values are far from being correct.

Since it is desirable at times to know the absolute value of surface tension, a series of 21 glasses of known surface tensions was used to determine the relation between these values and those obtained by the drop-weight method. These glasses[2] were of widely different, but unknown, viscosities.

Fibers were drawn from the series of glasses, the range of diameters being from 0.03 to 0.10 centimeters; drops were formed in the usual manner by means of a small flame from a hand-torch. The apparent surface tension was computed from the formula, $T = \frac{wg}{\pi d}$ where T = surface tension, w = weight of drop in grams, g = force of gravity in dynes, and d = diameter of fiber in centimeters.

Several determinations were made on each glass, the average deviation of a single determination from the mean being about ±4%. The mean of each set of

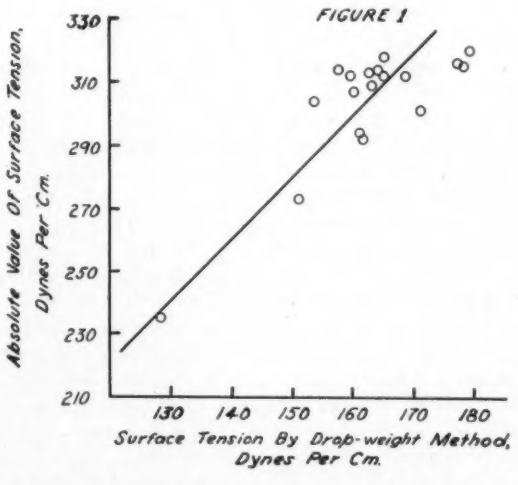

Figure 1. Absolute values of surface tension of glasses of widely different compositions plotted against drop-weight values. Multiplying latter values by the factor 1.86 produced absolute values with an average error of ±3%.

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THE SURFACE CHEMISTRY OF GLASS MOLDS

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Introduction

This chemical study of working surface of press molds and plungers for glass production was made to obtain information which should lead to improvements in gray iron molds or to methods of using them which would lengthen their productive life. Semi-quantitative methods were developed to establish gain or loss of constituents on or from the surface as compared with the interior. It is felt that as yet all of the aims of this investigation have not been accomplished. However, the work outlined in this paper can be considered as basic and fundamental to such research. Comments from readers are desired and will be welcomed in the hope that such discussion may lead to channels of future investigation.

Methods

Deterioration of working surface and extent of oxidation was obtained by making oxide prints[1] of cross-sections, the Prussian blue spots showing up in much greater density at the surface than in the interior. The printing paper was prepared by soaking No. 1 Whatman filter paper in a solution containing 6 per cent gelatin and 1 per cent potassium ferrocyanide, allowing it to dry hanging on a glass rod, and keeping it somewhat moist by suspending in a desiccator over water. A mold section was filed and then made as smooth as possible with abrasive paper, after which the filings were removed by an air blast. The sample was placed with the paper on it between two clean rubber stoppers or thick sheets of rubber and subjected to 2,000-2,200 lbs. pressure in a hand hydraulic press for 10 minutes. The paper was wet with fine spray or dipped in water after which the excess was shaken off. The paper was placed over a beaker of concentrated HCl for several minutes and allowed to dry. Where the gelatine had picked up ferric oxide tiny blue spots had formed.

Nitridation. Reagent.[2] Prepare a solution which is 0.1M with AgNO3 and 0.05 with MN $(NO3)_2$. Add NaOH solution until a slight precipitate is formed, after which the liquid is filtered into a dark bottle.

The surface of the sample is washed with alcohol. With a pipette, a small doughnut-like ring of about 0.4 cm. diameter of melted paraffin is deposited on the sample. One drop of 6 M HCl is placed within the ring. After several minutes the drop is withdrawn with a capillary pipette and placed in a micro-beaker which has been made by cutting off a vial about 1.5 cm. in diameter at a depth of about 1 cm. After covering one-third of a microscope slide with melted paraffin, scraping clear a circular space of about 0.5 diameter and placing one drop of reagent in the circle, a drop of conc. NaOH is added to the solution in the beaker. Then a paraffined cover with the hanging drop is immediately placed firmly on the beaker, thus sealing it and allowing any ammonia to diffuse to the reagent. Black spots are formed which have a tendency to collect. The density and size of the collection of spots indicate relative amounts of ammonia liberated from the nitrided iron. This diffusion can be accelerated by placing the beaker on a slightly warmed hot plate.

For each mold the tests were made on the working surface, a cross-section area, and a blank at the same time.

Silicon. Reagents.[3] (a) 10 g. of dihydrate of oxalic acid and a few crystals of citric acid are dissolved in water, diluted to 100 ml., and kept in a dark bottle. (b) 10 g. of ammonium molybdate (tetrahydrate) is dissolved in 100 ml. of water. (c) HCl one to one. (d) conc. HNO3. (e) Hydrofluoric acid.

Prepare a paraffin-covered surface of metal, leaving a circle of about .5 cm. uncovered. Add one drop of conc. HNO3 and, with a paraffined tube, one drop of HF. After several minutes, remove the acid solution with a capillary pipette and run into a very small test tube. Three drops of ammonium molybdate solution are added and a few drops of HCl in quick succession, and then several drops of oxalic acid solution. The intensity of the yellow color of the solution is proportional to the amount of silicon present. An occasional blank check test may be desired.

Phosphorus. Reagents: (a) 1 vol. conc. HNO3 to two of water. (b) Molybdic-sulfuric acid mixture: 1 vol. 7.5 per cent sodium molybdate and 1 vol. 10 N sulfuric acid. (c) Stannous chloride solution: 10 g. C.P. stannous chloride in 25 ml. conc. HCl. Dilute 1 ml. of this to 100 ml. on the day of use.

The samples are prepared as for silicon tests. Place one drop of the nitric acid on the surface, and, after about 5 minutes, transfer the drop to a small test tube and dilute with 1 ml. of water. Add 5-10 drops of the molybdic-sulfuric acid mixture and immediately enough of the dilute stannous chloride to bring out the molybdenum-blue color. The color density is proportional to the amount of total phosphorus present.

Magnesium. Reagents: (a) 1:1 HNO3. (b) conc. ammonia. (c) 6 N NaOH. (d) 0.1 per cent aqueous solution of Titan Yellow.

Place one drop of the nitric acid on the sample surface which has been prepared as described above. After action has ceased, remove the solution with a capillary tube and transfer it to a small test tube. Add one ml. of water and two drops of ammonia. Centrifuge, and transfer the supernatant solution to another tube. Two drops of NaOH are added, after which the combination is heated in steam to remove the ammonia as determined by smell. After cooling, a very small drop of Titan Yellow solution is added. The test should be run in duplicate on each surface, and a blank run is also desir-

SEMI-QUANTITATIVE TEST ON SURFACE AND INTERIOR OF GLASS MOLDS AND PLUNGERS

Item No.	Type Casting	From whom Obtained	Type Alloy	Remarks:	Oxide Print	Relative thickness of used surface 0 to 5	Nitridation	Si-Chem Relative	Si Spectrogr. Ratio	P	Mg.	Ca.	Cr.
1	#2569 Mold	Lancaster Lens Co.	Alten's #8	Used in lens production. Failed in less than 8 hours service. Inclusion. Less than 800 pieces of glass produced.	Very light throughout. Narrow darker edge 1	1	Very slight S 0 I 0	S 3 I 3	S 1.22 I 1.25	S 2 I 2	S Pres I Pres		
2	#2227 Mold	Lancaster Lens Co.	Alten's #8	Used in lens production. About half of expected life consumed. Approximately 25,000 pieces of glass produced.	Moderate throughout. Edge not distinct 2	2	S 1 I .5	S 1 I 3	S 1.19 I .92	S 3 I 2.5	S Pres I Pres		
3	#2514 Mold	Lancaster Lens Co.	Alten's #8	Used in lens production. Exceptionally long life experienced. Between 75,000 and 80,000 pieces of glass produced.	Rather uniform. Moderate heavy throughout. Narrow darker edge 2½	3	S 6 I 2.5	S 1 I 3	S .94 I 1.05	S 3 I 2	S Pres I Pres		
4	#1514 Mold	Lancaster Lens Co.	Alten's #8	Used in lens production of CaF2 glass. Higher temperatures involved. Mold nearing end of its life.	Dark edges. Gradually decreases from edges 2	4	S 4 I 2	S 3 I 3	S 1.04 I 1.08	S 3 I 3	S Pres I High		
5	#1122 Mold	Federal Glass Co.	?	Machine production of 9 ounce tumbler. Block Press Mold high speed. Casting manufacturer unknown.	Medium heavy throughout. No distinct inside edge.	2	S 2 I 1	S 2½ I 3		S 3 I 2	S 2 I 2		
6	#1183 Mold	Anchor-Hocking Glass Corp.	Binney #C-51	Machine production of tumbler. Block Press Mold.	Medium light. Medium outside edge. No distinct inside edge.	2	S 6 I 2	S 1 I 3		S 3 I 2	S 2 I 2		
7	#3469-3 Mold	Anchor-Hocking Glass Corp.	?	Machine production of boro-silica "Fire King" glass. Block Press Molds. Higher temperatures involved in production cycle.	Heavy oxidation decreasing to center. Wide edges.	4	S 6 I 2	S 1 I 3		S 3 I .5	S 2 I 1		
8a	#536 Mold	Anchor-Hocking Glass Corp.	?	Machine production of tumbler. Three-part Press Mold. Casting manufacturer unknown.	Heavily oxidized, gradually decreases from edge.	3	S 8 I 2	S 1.5 I 3		S 3 I 2	S 1 I 1		
8b	#535 Mold	Anchor-Hocking Glass Corp.	?	The figure of the mold was a deep diamond. These tests on diamond projections.	Heavily oxidized, gradually decreases from edge.	3	S 8 I 2	S 3 I 3		S 3 I 2			
9	#412 Mold	Federal Glass Co.	?	A blank for 12 oz. tumbler. Operated at high speed and temperatures. Casting manufacturer unknown.	Heavy oxidation throughout. Narrow edges.	3	S 4 I 2	S 3 I 3		S 3 I 3	S 1 I 1.5		
10	#PX Plunger	?	?	No data available. Tumbler plunger.	Oxidation throughout. Thick outside and inside edges 5	5	S 2 I 1	S 0 I 3	S 1.60 2d I 2.02 Sp	S 4 I 1	S Pres I Pres	Pres	High High
11	#160-21 Plunger	Anchor-Hocking Glass Corp.	Steel Casting 1.0% Carbon 14.0% Chromium	A chromium plated tumbler plunger. Manufacturer of casting unknown. Nearing end of production life.	Very light, decreases on edge. No distinct edge.	0	S 3.5 I 7	S 3 I 3		S 3 I 3	S .5 I .5		
12	#1124 Plunger	Federal Glass Co.	Alten's #8	Press plunger for 9 ounce tumbler. Tip of this plunger blew off during production. Had run for short time only.	Outside edge darkest, decreasing to inside which is also dark.	2	S 1 I .75	S 1 I 2	S 1.84 I 2.02	S 3 I 2	S Pres I High		High High
13	#1122 Plunger	Federal Glass Co.	Alten's #8	Tip for same type plunger described as Item 12.	Very dark. Darker edges.	3	S 1 I .75	S ⅛ I 3	S 1.39 I 1.75	S 3 I 2	S Pres I Pres		High High
14	#1602 Plunger	Federal Glass Co.	?	Manufacturer unknown. Little known of operating conditions.	Very heavy. No distinct edges.	3	S 4 I 2	S 1 I 3	S .53 I .90	S 3 I 1	S Pres I High	High I 2 S 1	
15	Plunger	Anchor-Hocking Glass Corp.	?	A rectangular plunger for refrigerator dish. Casting manufacturer unknown. Of life in glass production near.	Medium light. No distinct edges.	1.5	S 5 I 2	S 1 I 3	S I	S 3 I 1	S 1 I 2		
16a	#1907 Plunger	Federal Glass Co.	?	A press plunger for 7 ounce tumblers. Manufacturer uncertain. Long life in production.	Black surface. *Thin* edge moderate and throughout finely divided.	0.5	S 2 I 1	I 2 S 1		I 1 S 2	S 3 I 3		
16b	#1907 Plunger	Federal Glass Co.	?	Same as above, except surface had gray coloring.	Very narrow edge, oxide moderate and throughout finely divided.	0.5	S 1 I 3	I 3 S 3		I 1 S 2	S 1 I 3		
17	#1122 Plunger	Federal Glass Co.	Alten's #8	Press plunger for 9 ounce tumbler, tip of which had blown off in production. This item had run over long period.	Very thin edge—thickness of surface oxide heavier than that above but very fine.	0.5	S 3 I 3	I 3 S 1		I 0 S 1	S 1 I 2		

able in order to distinguish between the yellow of the blank and the light orange when the Mg. content is very low.

Sulfur. Set a short length of glass tubing of about 0.5 cm. inside diameter upon the surface and pour paraffin around the base. Drop one drop of 1:1 HCl into the tube and place wet lead acetate paper over the opening. A graying or blackening of the exposed paper indicates sulfide sulfur.

Add two drops of water to solution obtained above, and transfer to a black spot plate. Add a small drop of dilute barium nitrate and note any finely divided white precipitate which indicates the presence of sulfate.

Results

The results of these tests on nineteen molds and plungers are given in Table I. Sulfur tests were made on only a few samples. Sulfide sulfur tests, as would be expected, were positive only when the sample had had very little use. A plunger which had a very thick working surface gave a negative test for sulfate sulfur on the surface. The data may be summarized as follows:

1. The thickness of the working surface varied from one so thin as not to be distinct in a high-chromium alloy plunger to one heavily oxidized plunger which had a surface over a millimeter in thickness. The first three samples show especially that the oxidation progresses into the interior with use as well as on the surface.

2. In all samples but one (which had a very thin working surface) the nitride content was greater on the surface than in the interior. Again the first three samples show progressive nitriding, both interior and surface.

3. The first sample, being used only a few hours, showed the same Si content in surface and interior. Three other samples showed about the same Si content on surface and interior. One was a high-chromium alloy, another was used at high temperature with fluoride glass, and the third had a very thin working surface. In order to test the validity of our methods, a number of these samples were analyzed spectrographically. The results show desilication in the same samples but the ratios obtained were smaller. The spark may have penetrated more deeply through the softer surface, thus giving heavier spectrum lines for Si.

4. Again the hardly-used first sample showed no accumulation of P on the surface. The molds used for fluoride glass at high speed and temperature and the chromium alloy showed the same P content on surface and interior. But all of the others showed accumulation of P on the surface.

5. Some of the magnesium tests were made chemically and others spectrographically. We do not have the ratios for the spectrographic results, but eight samples showed higher Mg content in the interior, one a larger Mg content on the surface. The remainder showed not much difference in surface and interior content of Mg. Evidently, glass can pick up MgO. Steel men were surprised to find Mg and Ca lines in the sample.

Discussion

The working surface consists probably of some unoxidized iron, a high amount of ferric oxide, some ferric phosphate, iron nitride, very little silica, small amounts of CaO and MgO, and some graphite, especially when graphite or hydrocarbon oils have been used as lubricants. If ground cork has been used in breaking-in the mold, the ash of it may account for some phosphate.

It is likely that, at the speed with which the plungers punch the glass, some air does not escape and is forced under high pressure into the pores of the surface of molds and plungers, thus causing oxidation and nitridation at high temperature, the latter at a lower rate and not to such depth. The effect of interior oxidation alone on the length of the useful life of a mold is probably not known. The effect of oxidation, if any, upon the rate of graphite formation has not been determined. The prevention of oxidation can be expected to lengthen the useful life of gray-iron molds and plungers, yet its desirability is very infrequently mentioned in the literature. It can be presumed that purely metallographic methods have failed to solve the problem.

Plating with certain metals should prevent oxidation. According to McGregor,[4] chromium-plated Meehanite press molds have longer life than chilled gray-iron molds. Chromium-plated molds do not need lubrication.[5] Arkharov, Kotukhova, and Redkina[5] have found that thin coats of nickel or chromium increase the oxidation of iron at high temperatures, but that thicker coats prevent it.

Lorig and Krause[6] have patented a method of chilling cast-iron surfaces so that they contain small fractional percentages of tellurium. Data are given which show that the surface is resistant to oxidation at higher temperatures, but data showing that this treatment increases the usefulness of molds in actual glass production are not available.

Greed[7] has patented a process for autogenously welding an alloy of nickel, copper and tin upon a base of cast iron.

Nitriding the molds and plungers after machining should, if deep enough, prevent oxidation and sticking. In this laboratory, two small molds and a small plunger were nitrided with ammonia at 950° F. for about forty minutes. They were used in semi-automatic pressing of glass. The report came back that they were used twice as long as untreated molds before the surface had to be reworked. There was no complaint about sticking. Perhaps deeper nitriding would have given better results. If nitrided iron were wetted by glass, nitrogen should not have accumulated on the used surface of the molds examined. Cooke[8] found that ordinary enamel does not stick to small steel samples in an atmosphere of nitrogen, but does stick if the piece is first oxidized at 750°. Because the nitrided surface is hard, pieces which are sharply engraved or figured should have a longer useful life. Since nitriding need not be a complicated process, it might be economical to renitride molds and plungers after the surfaces have been repolished.

Since the air with 21% oxygen causes appreciable oxidation, it would seem that flooding the mold cavity with nitrogen immediately after the removal of the glass object should greatly decrease the rate of oxidation on and within the mold surface and to a lesser extent on and in the plunger and also accelerate the rate of nitridation. Although nitrogen would be more expensive than an airblast, it might actually be more economical if the molds could be used for longer periods before breakdowns occur or the reworking of the surface becomes necessary.

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SERVICE TRAINING PROGRAM AT HARTFORD-EMPIRE

Experience has yet to lose her hold as the world's greatest teacher, despite all the shortcuts men have devised to undermine her authority. This is true in any business, and especially in the work of the industrial engineer and machinist. However, one of the most interesting aspects of our industrial life during recent years has been the attention given by leading manufacturers to the *way* a man gains his experience, the *way* he learns his trade, the *way* he serves his apprenticeship. Such considerations have led to the establishment of training courses in almost all major plants throughout the country, and the importance of job-schooling is being recognized more and more. This trend toward well organized study of machines and their operation in the first years of an employee's service in his firm is illustrated in the service training program at Hartford-Empire.

Organized training of new personnel was not a problem confronting the group of engineers who started Hartford-Fairmont Company in 1912. These men, later to become executives in Hartford-Empire, were actually training themselves in hitherto unknown fields of glass production. Young men who joined them in the years that immediately followed inevitably became students as well as engineers, for the very nature of the company's work was the gradual application—by trial and error—of chemistry, physics and engineering science to machinery for producing finer and cheaper ware.

Not until Hartford began licensing its larger and more complicated machines to an ever-increasing number of licensees did the systematic training of installation and service men become important. Hartford foresaw the advisability of a comprehensive training program long before the need for such organized instruction arose. As long as the original engineering staff could supervise the assembly, installation and servicing of Hartford machines and equipment, the new employee could learn by watching and listening to the creators of those machines and equipment. This was the traditional "on-the-job schooling".

But with the growth of the company, these men were required to spend more time with administrative duties and consequently had to be replaced in the field by men with similar understanding of the machines. In this transitional period, Hartford gradually put its training plan into full operation, watching its initial progress carefully, altering the program as occasion demanded, and considering all phases of the program as carefully as Hartford engineers had tested and watched the development and use of Hartford's first machines.

The first step in the evolution of a sound training program at Hartford-Empire was an analysis of the abilities of the men then employed on installation and service jobs. It was found that Hartford had developed a group of 'specialists', men who were thoroughly familiar with specific operations in assembly, installation and repair but lacked a broad knowledge of Hartford's overall services to the glass industry. Eventually, reasoned Hartford executives, this would lead to congestion when a certain problem with a certain machine might be prevalent among all licensees of that machine. Thus one or two men would be called upon to perform miracles in servicing if there was to be no interruption in the steady operation of Hartford machines in licensees' plants. Furthermore, in periods when certain other machines required no servicing, men skilled in the installation and operation of those machines would be relatively inactive.

In anticipating this condition, Hartford department heads reached these conclusions: (1) The start of the training courses must be based to a great degree on the individual—his natural aptitude, his availability for instruction, his past experience; (2) The schedule of training courses must, of necessity, be kept flexible, permitting personnel to perform duties in licensees' plants and be at all times ready to take on emergency work; (3) Machines and parts must be part of classroom equipment and actual participation in servicing jobs in the field should supplement each phase of instruction in the home plant. To set a training plan in motion under this policy at first seemed to offer nothing but confusion. However, it was for the very reason that flexibility was a keynote in the plan that all men involved—trainees and Hartford engineers acting as instructors—kept a lively interest in ironing out the complications which, in the first months, were continuously challenging.

In the beginning, lectures, group discussions, demonstrations were scheduled—and *schedules were kept.* A trainee for some new phase of servicing work might be held up in the field and unable to attend. That did not mean, however, that his training stopped. Complete reports of all training sessions were meticulously kept and filed. On his return to Hartford, the trainee obtained second-hand knowledge of all points covered and in his spare time saw to it that such information became first-hand knowledge—either by attending a 'repeat' session in the course or consultation with the engineer who conducted the class. While not the most satisfactory procedure, it was enthusiasm for the courses themselves among the men involved which, month by month, gave new impetus and brought increasing success to the training program as a whole.

For example, a man who had been with Hartford for five years, became a key service man on installation of the Hartford Stackers. The training courses, as first drafted, gave him an opportunity to learn about the Single Feeder in the year that followed.

As originally planned, instruction originated in the Hartford plant. Soon, leaders in all training programs altered schedules to include training in the field. Under the guidance of the ranking engineer in installation and service of Feeders, the man who previously was an authority on Hartford Stackers found himself a willing student of field engineers who were devoting themselves exclusively to the installation and maintenance of the Feeders throughout the country. Thus the training plan took shape. It resulted in complete protection for Hartford licensees by greatly increasing the number of trained Hartford personnel in diversified fields, but it was still a plan that depended primarily on the individual incentive of Hartford men—trainees and teachers—to keep detailed records of their progress.

The success of the program in its initial stage was

the stepping stone to another phase of the program. Records had to be kept up-to-date; men in training were moving too swiftly from the jurisdiction of one engineering department to the other; more courses were added; more group meetings and discussions took place.

Again, in advance of the actual need, Hartford-Empire called in a coordinator and director of its training program, gave him and his staff sole right to consolidate the reports of its trainees and instructor. Holding to the premise that flexibility was essential, these men took the detailed records of all training up to that time, then laid out a year's program most adaptable to fluctuating itineraries of field men and rapid growth of the company. Here it was found that a training program for new men became far less complicated than adjusting the indeterminate schedules of men already in Hartford's employ who had become students and instructors at the same time. First, it was concluded that new men must be trained systematically, attending classes under a schedule which provided them with a background of Hartford's history, growth, the company's place in the industry and its policy, their responsibilities as Hartford representatives, the obligation of Hartford to its licensees and, finally, several actual jobs under a supervisor away from Hartford in a licensee's plant. To this program was added the far more difficult business of properly arranging courses which, as "refreshers", might be attended by Hartford men coming in from the field. These men, too, became enthused with the possibility of widening their knowledge of Hartford's machines and long range developments in Hartford's service.

The desire of Hartford "graduates" to take "post-graduate" courses as time permitted was a great stimulus to the young man who was looking at such an intricate mechanical assembly as the I. S. machine for the first time and was somewhat appalled by what he saw before him.

"I'll never get the hang of this," the new employee, an engineering school graduate, might well have said to himself. But there were most likely some reassuring words from an older Hartford man in the group: "I like getting back—it gives me a chance to check up on that new design for the plunger. Now, fellows, if you ever get into trouble with this part here (he is looking at a part in a new I S. machine which is nearing completion on the assembly floor), there's one way I've learned on the road, and in training, which makes it twice as simple. . . ." The new trainee gains assurance at the start.

Now that the training program at Hartford is in full swing, its supervisors have stressed new features: special emphasis is put on human relations; for, more than in most companies, a Hartford man supervises work in plants other than his own. He must be able to work well with other men whom he may not have previously met, give them the right information at the right time, and yet not trespass upon plant operations which do not directly concern him. He may have an assistant with him who, on the next visit to the same plant, may be the supervisors. Between the first and second visits that assistant will have undergone further Hartford training which will fully qualify him to take over the reins.

Taken at random, below is a sample week's schedule of the training program as it is now operating in Hartford. Note that its divisions and topics permit an informal and realistic approach to Hartford machines, their uses and servicing requirements.

During the last year at Hartford-Empire, the same note of flexibility and lack of a rigid classroom curriculum has underscored every move made in the growth of the training plan. Since the company is now able to place a man in training the moment he joins the organization, the entire program becomes easier to regulate. But by far the greatest result achieved by this training has been the widening and development of engineering talent in Hartford men. Bill is no longer an I. S. man exclusively; he is ready to install or service a lehr, if occasion demands, because his company realized years ago that the broader the scope of Bill's training, the greater Bill's value to the company and, in turn, to the glass industry.

But, over and above planning, flexible schedules and teaching methods in producing a train-and-work formula for men in industry today, Hartford has found that the prime requisite for the establishment of a sound training program is a man's natural enthusiasm for varying his interests and increasing his knowledge of the over-all operation of a company and its work. Because of this training principle, Hartford-Empire can be sure of serving the industry better than ever in the years ahead.

A.M.	*Monday*	*Tuesday*	*Wednesday*	*Thursday*	*Friday*
8 to 9	Personnel Procedure	Written answers to 1st day's quiz	Written answers to 2nd days' quiz	Written answers to 3rd day's quiz	Written answers to 4th day's quiz
9 to 10	Induction	Forehearth Discussion #1	Forehearth Discussion #2	Forehearth Discussion #3	Forehearth Discussion #4
10 to 11	Industrial Supervision Course—Discussion #1	Practical demonstration	Practical demonstration	Practical demonstration	Practical demonstration
11 to 12	Ditto	Quiz session	Quiz session	Quiz session	Quiz session
P.M.					
1 to 2	Theory of glass-making, description of	Industrial Supervision Discussion #2	Industrial Supervision Discussion #3	Industrial Supervision Discussion #4	Industrial Supervision Discussion #5
2 to 3	H-E machines and their purpose	Ditto	Ditto	Ditto	Ditto
3 to 4	Trip through plant	Blueprint interpretation	Blueprint interpretation	Blueprint interpretation	Blueprint interpretation
4 to 5	Quiz session	Report writing techniques	Report writing techniques	Report writing techniques	Report writing techniques

SPEEDING UP GLASS MELTING

A. Dietzel [*Glastechnische Berichte 21* (1943) 198-204] made an extensive study on the factors determining the melting speed of glass batches.

Among the raw materials which became scarce in Germany during the war and for which substitutes had to be developed, borates and boric acid were by far the most critical. The economic advantages of borates for glass melting were first discovered in the U. S. A. but shortly afterwards adopted in England and Germany. Additions of 0.3-0.5% B_2O_3 to the glass batch bring about a material decrease in fuel consumption and became the rule in European tableware, window and container glass. The author pointed out that although this practice of using minor additions of boric acid was practically unknown fifteen years ago, it was not possible to simply omit this constituent and restore the former melting practice. The effect of minor additions of boric acid is twofold. First it facilitates melting and fining and thus helps to economize fuel. Boric acid or borax is an important flux in most glass batches. Secondly, it improves the working properties of glass which were found to be particularly important for the manufacture of the Thuringian Apparatus Glassware.

The experimental work aimed at the finding of a substitute for boric acid as a flux. Because of the shortage of other raw materials, the two best possibilities, addition of fluorides and partial replacement of CaO by BaO, were not further investigated. The results of Dietzel's work lead to the following conclusions and suggestions to the glassmaker:

1) Proper grain size distribution of the batch constituents is an important factor. The grain sizes of the batch constituents and their ratios should be determined for each individual case. An optimum results from the influence of the reaction surface and of the thermal conductivity of the batch. The influence of the latter depends in turn on the heating speed. 2) Water vapor is a powerul flux. Additions to the glass batch such as magnesium chloride, zinc chloride and other materials which retain the moisture are helpful. 3) Titanates have a fluxing effect which can be utilized.

From a practical point of view, the combination of these three factors may help to overcome the melting difficulties which the glass industry encountered through the withdrawal of borates. He recommends specifically the addition of magnesium chloride in combination with sodium metatitanate and control of the grain sizes of all batch ingredients after the establishment of the optimum size distribution.

The paper contains a critical discussion of the previous literature on this subject. The methods for determining the speed of glass melting were enumerated. a) Weight loss or the evolution of carbon dioxide (Hedvall, Tammann, Stanworth). b) Electric conductivity of glass batch (Krause and Weyl). c) Uranium addition as fluorescence indicator (Kühl, Rudow and Weyl). d) Visual observation (Potts, Turner and associates).

For his experiments, the author constructed a device which recorded electrically the loss in weight of the glass batch, which was heated in a platinum crucible using a constant heating rate. In connection with his studies on the influence of the grain size distribution and the influence of the heating rate, the author measured the thermal conductivity of the batch. It was found for example that on heating the glass batch 5° C per minute, finely powdered quartz reacted faster than the coarse sand grains. If, however, the heating rate was increased to 20° C per minute the glass batch containing the fine powder was found to be slower. The finely powdered batch was more voluminous than the sand containing batch and as a result had a thermal conductivity which was only two-thirds of that of the denser coarse aggregate.

A second method which proved to be very useful was based on the measurement of the height of the batch pile, when heated in a muffle furnace. The flattening of the pile was plotted as a function of the temperature. Two different heating rates were used. The part of the curve which was nearly a straight line was extrapolated and the melting behavior of the batches characterized by the temperatures where the deformation begins (B) and the endpoint, the temperature where the top of the pile had fallen down 20 mm. (E). All batch piles were made by means of molds to insure constant shape.

The composition of the glass batch was: 74 parts sand, 27 parts soda ash, 18 parts limestone corresponding to a glass of: 74% SiO_2, 16% Na_2O, 10% CaO. To the batch were added 0.7 parts by weight of the constituent to be examined. This ratio was chosen because 0.7 parts of the crystalline borax corresponded to an addition of 0.25 weight % B_2O_3, a representative figure of the commercial window and container glass composition. The results are given in the following table:

Addition	5°/*min* *B*	5°/*min* *E*	20°/*min* *B*	20°/*min* *E*
Batch without addition ...	960° C	1045° C	1075° C	1140° C
Cryolite synthetic	800	900	....	....
Ammonium chloride	850	960	1035	1110
Sodium silica fluoride	870	960	....	....
Zinc chloride, hydrate	880	975	1025	1100
Sodium fluoride	885	955	....	....
Sodium chloride	890	960	....	....
Barium perchlorate	915	995	....	....
Zinc chloride + zinc oxide 2 $ZnCl_2$ + ZnO	900	980	1025	1140
Basic zinc chloride	910	995	....	....
Magnesium chloride, hydrate	875	975	1025	1090
Sodium titanate (Na_2TiO_3)	830	1020	....	....
Sodium dititanate ($Na_2Ti_2O_5$)	940	1025	....	....
Ammonium nitrate	940	1015	1075	1160
Ammonium sulfate	...	....	1040	1150
Zinc oxide	950	1030	....	....
Borax crystals	920	995	1035	1110
Fluorite	920	990	1000	1085
Sodium chloride and calcium chloride 1:1..	920	990	....	....
Sodium-titanium-silicate glass (V 26, I.G. Farben)	945	1035	1025	1120
Aluminum chloride	950	1020	....	....
Basic magnesium chloride.	930	1030	....	....
Calcium chloride + ammonium chloride 1:1	930	1005	....	....
No addition but heated in an atmosphere containing water vapor	895	950	....	....

(*Continued on page* 370)

FEDERAL SPENDING AND THE GLASS INDUSTRY

By KELCY KERN

The proposed federal budget, for the year ending June 30, 1947, should be of particular interest to the glass industry because of its implications and the possible effect of many of its provisions on the general economy of the United States. This budget has been the subject of much discussion ever since its presentation to Congress last January.

According to a recent study made by a national research organization, the 1947 federal budget as proposed by the President last January called for the expenditure of $35.1 billion. Revenue was estimated at $31.5 billion, leaving an anticipated deficit of $3.6 billion, not including the net effect of government corporation activities. This was the sixteenth consecutive budget submitted to Congress which provided for expenditures in excess of anticipated revenue. The expenditures proposed in this budget are actually four times those proposed for the peacetime year of 1939.

Few industries would benefit more from the result of a balanced budget than the glass, and there are many reasons for this. For one thing, it is now generally agreed that deficit federal spending leads to a spiral of rising prices and rising costs and this results in inflation. As contracts are usually made on the basis of current prices, losses occur when raw materials and supplies must be bought on a rising market.

No business can exist or continue if it constantly operates "in the red," and the business of government is no different. However, if the government of the United States goes bankrupt, it will take all other business along with it.

We are told that a large part of this deficit in the budget now in the making comes from, or is the result of, "the biggest public works program in our history"—and this at a time when the demand for private construction of homes and buildings far exceeds the capacity of the glass industry. The 1947 budget calls for the expenditure of $1,083,000,000 for public works, a large proportion of which may be questionable as to its needs or the purpose to which it will be put. Also, this item will get "priority" over essential domestic housing, even that of veterans housing—priorities both as to materials and to labor. Private enterprise will be harmed rather than helped by this operation since most economists generally view "public works projects" as only a "cushion" to relieve depression or slack times.

The government bases its estimate for revenue, to pay this tremendous bill, upon the highest burden of taxation ever imposed upon the American people by their federal government—and at a time when the nation is at peace with the world.

This excessive taxation is a burden on the glass industry as well as every other. Income from taxes is put at $29.5 billion, and an estimated two billion dollars will be received from the sale of surplus war property. In 1947 the nation will face the largest total of additional spending proposals for peacetime purposes it ever has confronted. Adoption of even a few of these could add multi-billion dollar expenditures to this year's proposed total. It has been said that 1946 is "the year of decision." For the first time in 16 years, the American people have the chance to make a cleancut decision as to their federal government's spending policy.

Shall this government continue its big spending with its unavoidable waste, duplication and needless extravagance? Or, shall it now, when opportunity for employment is so favorable, initiate a balanced budget as peacetime policy, together with the thrift and efficiency which that policy encourages? These questions are being asked by all sensible business men.

Deficit spending before and during the last war created our enormous public debt, and unless the federal budget is balanced during these peacetime years, that debt is likely to increase. Said Harley L. Lutz, Professor of Public Finance, Princeton University: "We have no valid basis upon which to rationalize the existing public debt as a benefit. It should be recognized as a serious problem. Instead of adding to it, even for such important things as unemployment relief, we should plan to deal with this and other such problems in ways that will avoid further debt increase."

"The tendency of government to resort to borrowing to engage in 'made' work, and in this way directly compete with private enterprise is considered by most economists to be unhealthy for the country, and for the industries and services with which it enters into competition."

Leading members of both parties in Congress recently issued a statement which reads in part: "We cannot afford to spend money we do not have, we cannot afford to continue war agencies long overdue for demobilization, or war functions of doubtful value in civil agencies. The federal structure needs rebuilding for peace now, and from the ground up. We cannot afford, nor do we need at this time in view of widespread opportunities for employment, such things as the biggest public works program in our history, or a general governmental expenditure almost twice that of prewar 1939. Every dollar we spend now must be justified by overwhelming proof of its need."

What may be done by industry to achieve a balance in the federal budget this year? The vast nationwide influence of independent and other glass organizations, working in cooperation with other interested groups, can do much in this direction, mainly by making their views known to Congress. Many measures are being put forward calling for even greater federal expenditures in 1947, with a resultant further swelling of the public debt and possibly even higher taxation in the future. Many of these measures are being challenged by national, state and local taxpayer groups who favor sound government financing. Factual material of direct interests to the glass industry is being supplied free upon request by the Tax Foundation, 30 Rockefeller Plaza, New York City.

• The Brown Instrument Company, Philadelphia, has announced the purchase of a five-story and basement structure in that city.

SINTERED GLASS*

By E. G. DORGELO

Introduction

In the manufacture of certain articles in which many metal parts (e.g. leading-in wires) must be fused into glass close to each other, it is sometimes impossible, due to the too low fluidity of the molten glass, to force the drop of glass between the metal parts. In such a case glass in powder form can be used, and this can be introduced between the metal parts before fusing. The glass obtained after fusing, which is not completely clear, is called sintered glass, and contains many very small air bubbles. In this article various properties and possibilities of this glass are discussed.

In the manufacture of incandescent lamps, electronic and gas-discharge tubes different special kinds of glass are used, which must satisfy certain requirements for each type of valve or lamp, and therefore may differ very much from each other. A kind of glass whose properties and constructive possibilities are particularly favourable for one type may be quite unsuitable for another type.

For the development of a new lamp or valve, therefore, the possibilities offered by different kinds of glass should be subjected to an extensive investigation. If the existing kinds of glass are unsuitable for the application in view, an attempt is made to find a new and better kind of glass. In the case of different types of valves the progress of their development depended almost exclusively on the manufacture of a suitable new kind of glass.

One example is the sodium lamp covered on the inside with borate glass[1], which is resistant to sodium vapour; further the high-pressure and super high-pressure mercury lamps, where it was necessary to find types of glass for the covering of the metal leads through the quartz[2]. In the development of transmitting valves for very short waves, use was also successfully made of special new kinds of glass, the electrolysis-free glasses[3].

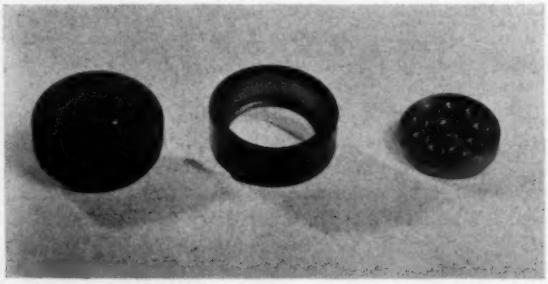


Fig. 1. Mould of metal with separate bottom and cover.

While in the examples mentioned here the new glasses are distinguished from the older ones by their chemical composition, in the case of "powder glass" an attempt has been made to create new possibilities by a modification in the physical structure. The stimulus for this attempt lay in a difficulty which occurs in the manufacture of articles in which many metal parts (for example leading-in wires) must be fused into glass close to each other. The liquid glass must then be forced between the metal parts, and the method fails when the spaces between are so small that a drop of molten glass, even under high external pressure, cannot penetrate sufficiently far into them, perhaps because of the fact that cooling takes place too rapidly as a consequence of the heat conduction through the metal parts. This difficulty can be overcome if, before the fusing in, the glass in fine powder form is introduced directly into the space where it belongs, the whole then being heated to a temperature at which the glass melts. The structure of the somewhat turbid sintered glass which is obtained upon fusing the powder is not homogeneous; it contains numerous very small gas or air bubbles which more or less modify the different properties of the glass. In general these changes are not of prime importance. Nevertheless, they may sometimes make possible constructions which are impossible with normal glass. Examples of such cases where preference is given to powder glass will be given later in this paper.

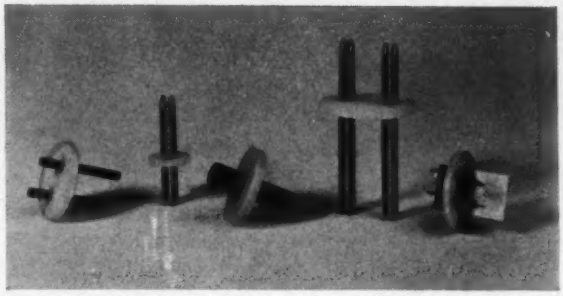


Fig. 2. Fused-in metal tubes and strips in powder-glass bases for valves.

Sintered glass offers great advantages in the manufacture of valves and lamps for experimental purposes, due to the rapid and simple manner in which almost any desired lamp base can be made. Metal leads can be fused in at the same time that the base is made, while the process can be used for every kind of glass, including the kinds which are very difficult to soften.

The Employment of Sintered Glass

The raw material, powdered glass, is obtained by grinding up pieces of glass. This powder is cast in a mould in which the metal parts to be fused in are already present. Care must be taken that the glass powder fills up the spaces well between the metal parts. After covering the mould the whole is heated to a temperature at which the glass is very fluid, so that only slight pressure is enough to fill even the smallest cavities.

The coefficient of expansion of the material of the mould must be adapted in a certain way to that of the glass. The wall of the mould must not clamp the solidified glass article; the coefficient of expansion of the material of the wall of the mould must therefore be smaller than that of the glass. The bottom of the mould (which is separate from the wall) must, on the other

*Reprinted from Philips Technical Review, Philips Research Laboratory.

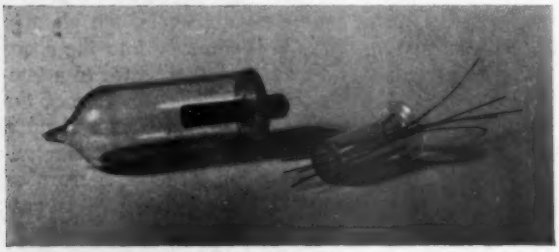
1. Philips techn. Rev. 2, 87, 1937.
2. Philips techn. Rev. 3, 119, 1938.
3. Philips techn. Rev. 6, 255, 1941.

Fig. 3. The leads can be fused-in through sintered glass bases in almost any number and arrangement.

hand, have by preference the same coefficient of expansion as the glass, since otherwise there is a danger that, upon cooling, any leads and the like which are fastened into the bottom will be bent. A mould which possesses the properties mentioned is shown in Fig. 1.

Besides lead-pins, differently shaped objects can also be fused in, for instance metal strips, tubes, nuts, etc. (Fig. 2). The number of pins, the distances between them and their grouping is subject to practically no limitations when sintered glass is employed. Fig. 3 illustrates the great variety possible.

Furthermore it may be pointed out that simultaneously with the fusing-in of leads in a lamp or valve base the glass envelope can also be welded on. This envelope is then placed in the mould before the fusing of the powder



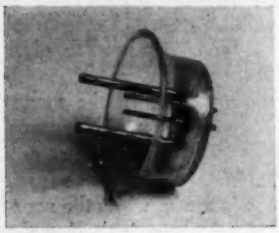


Fig. 4. Envelope and pinches, the powder-glass bases of which are welded to the envelopes at the same time that the powdered glass is fused.

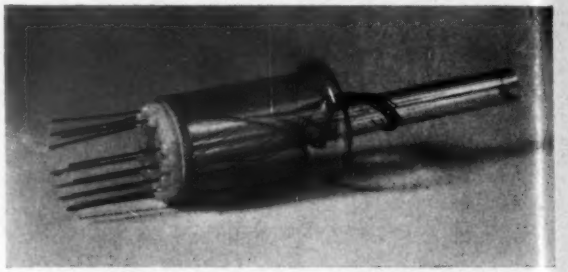
glass base; the upper part of the mould must then be removed. In this way the separate welding process is elminated. This process is, of course, subject to the restriction that it can only be applied in those cases where the electrodes inside the envelope are resistant to the heat radiation of the glowing mould. The tubes and bases shown in the photographs Fig. 4 are made in this way. It is obvious that other glass parts, such as an exhaust tube, can be welded in simultaneously with the fusing of the valve or lamp base (Fig. 5). To prevent the exhaust tube from collapsing during the fusion, it is previously sealed at the bottom and filled with fine sand, which is shaken out after the fusion.

A special manner of fusing in, which is impossible with glass envelopes, can be applied to metal envelopes by strongly heating the edge of the metal envelope and then pressing it into the likewise previously heated sintered glass base. The projecting edge can be removed later. In this way it is possible, for example, to fasten lead-glass discs into an iron can. Because of the fact that the coefficient of expansion of the iron is larger than that of the glass, the iron upon cooling is clamped around the glass, giving a very reliable connection[4]. Nor is it of importance in this method whether the cross section of the envelope is a true circle.

4. In principle this method of fusing-in is also possible with discs of clear glass.

Properties of Powder Glass

1) *Specific weight.* The circumstance that there is a very large number of small gas bubbles in sintered glass



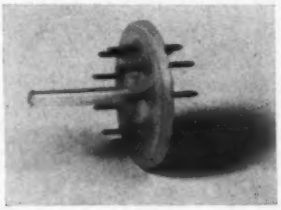


Fig. 5. Exhaust tubes can be welded in simultaneously with the fusing of the lamp or valve base.

affects different properties; it is clear that for example the specific weight is smaller than that of the original glass. The decrease depends upon the size and the number of bubbles and is usually of the order of magnitude of 5 to 10 percent; with very fine powder the decrease is greater. The diameter of the bubbles usually lies between 10 and 50 μ. The number of bubbles per mm^3 amounts to several thousands.

2) *Electrical properties.* When a block of powder glass is situated in an electric field the field strength in the glass will be much smaller than in the gas or air bubbles, as a result of the very different dielectric constants (glass: approx. 7, air: 1). The field is thus concentrated in the bubbles.

If we consider a piece of clear glass with only a few large air bubbles, the field concentration in these bubbles may be so high that the enclosed gas becomes ionized, which may lead to complete breakdown. Glass for high-voltage apparatus (X-ray tubes, for example) must thus satisfy the requirement of being free of bubbles to a high degree.

The situation becomes quite different when the air in the glass is divided into very many small bubbles. The potential difference between the boundary surface is then uniformly distributed over the numerous intermediate gas bubbles, so that the potential difference per gas bubble is so low that danger of ionization is out of the question. With powder glass indeed values of the breakdown voltage are found which are just as high as those measured on glass which is free of bubbles.

The electrical field in a medium in which there are

(*Continued on page* 364)

PROCESSING AND USE OF SELENIUM

In the April 1946 issue of the *Canadian Mining and Metallurgical Bulletin*, Schloen and Elkin have contributed a lengthy article dealing with the operations at the Canadian Copper Refiners Montreal East Plant. Part of the article deals with the recovery and processing of selenium. Inasmuch as this element is an essential ingredient in many glass batches and as it is always interesting to know how glass raw materials are processed, this part of the article has been summarized.

The selenium and acid-recovery departments are in a 60 ft. by 60 ft. self-contained building about 200 feet from the silver refinery and tank house.

Four materials are received at the selenium plant for processing: crude selenium from the chain roaster scrubber, neutralized slag leach solution and two types of scrubber solution. Typical assays of the materials are given in Table I.

TABLE I

TYPICAL ASSAYS OF MATERIALS RECEIVED AT SELENIUM PLANT

Material	*Selenium grams per liter*	*Tellurium grams per liter*	*H_2SO_4 grams per liter*
Doré scrubber solution	23.87	2.14	207
Chain roaster scrubber solution.	17.62	0.03	249
Neutralized slag leach solution..	93.70	0.47	....
	Selenium	*Tellurium*	*H_2SO_4*
Crude selenium	99.12%	0.010%	....

Silver refinery solutions are pumped to storage tanks at the selenium plant from which they are drawn to precipitators as required.

The precipitation of selenium from selenious acid solutions may be represented by the equation:

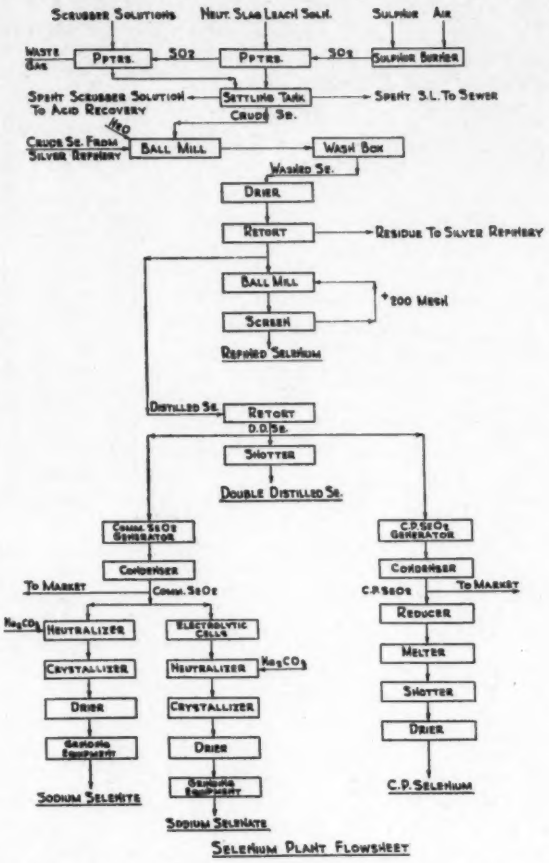
$$H_2SeO_3 + H_2O + 2SO_2 \rightarrow Se + 2H_2SO_4$$

which shows that, for every pound of selenium precipitated, approximately 2½ lb. of sulphuric acid is generated. The acid, after selenium removal, is recovered and concentrated to 80 per cent H_2SO_4 for re-use in the silver refinery slimes digestion.

The precipitators, of which there are six in series, are lead-lined, dished-end tanks, 5 ft. in diameter by 8 ft. 6 in. high. Each precipitator has a sulphur dioxide inlet and outlet, an inspection manhole, a solution inlet and a bottom discharge for solutions after precipitation is complete. Cooling coils maintain the temperature of the solution between 60° and 90° F. during precipitation. Above 100° F., selenium precipitate becomes plastic and is difficult to clean from the precipitator, while below 60° F. a large excess of sulphur dioxide is required to saturate the solution.

The six precipitators are connected in series in a closed circuit. Series precipitation under pressure aids in securing effective recovery of selenium with the minimum amount of sulphur dioxide. At the refinery, for every pound of sulphur burned, an equal amount of selenium is precipitated which indicates an efficiency of 80 per cent according to the equation given above.

The time required for precipitation varies directly with the concentration of selenium in the solution treated and averages five hours. When a sample shows completion of precipitation, that tank is cut out of circuit. The precipitator is vented to remove excess sulphur dioxide, the manhole cover is opened and the solution with selenium precipitate is washed through the bottom discharge to the settling tank.



SELENIUM PLANT FLOWSHEET

Crude selenium assays from 0.01 to 0.10 per cent Te, depending on the source of the material. Selenium cleaned from the scrubber is of lowest tellerium content while that precipitated from neutral slag leach is of highest.

After the crude selenium is washed by grinding through a ball-mill, it is filtered, oven-dried and then charged to the retorts in 1000-lb. batches. Retorting crude selenium serves three purposes: it drives out moisture, reduces the tellurium, iron and copper content, and recovers in the non-volatile residue any silver and gold that may have been in the crude selenium.

The retort bowls and covers are made of cast-iron. After every second charge, a retort is cooled, removed from the furnace and cleaned of any accumulated residue. The residue, containing about 65 per cent Se,

(*Continued on page* 366)

INVENTIONS AND INVENTORS

A Summary of Recently Issued Patents of Interest to the Glass Industry

Feeding and Forming

Patent No. 2,401,994 shows improved glass feeder shears invented by Walter C. Weber and assigned to Hartford-Empire Company. With reciprocating shears, the lower blade has a tendency to bat or throw the upper end of the severed gob so that it will not fall straight into the mold. In order to overcome this tendency drop guides or bat preventers have been used to take the thrust of the upper end of the gob under the influence of the lower shear blade. Such guides have to be set properly to give good results.

This invention makes use of the guides unnecessary. This is done by stopping the shearing movement of the lower blade before severing of the gob is completed. Thus, at the instant of completing the cut, the upper blade is acting against a stationary lower blade. As it is the movement of the lower blade which gives a lateral thrust to the gob, the gob falls straight without the use of a guide.

Fig. 1 is a view looking down on a pair of shears having an upper blade 10 and a lower blade 11 carried by arms 14 and 15. The arm 14 swings about a pivot 17 while the arm 15 swings about a pivot 18, both of these pivots being on a center line passing through the feeder orifice indicated by dotted lines at 21. The arm 14 has an extension 30 connected by a link 21 with the piston rod of an air cylinder 26 by which the arm and its blade are reciprocated between the full line and dotted line positions.

The arm 15 is actuated through an arm 39 engaged by the end of a piston rod 41 projecting from an air cylinder 42. This cylinder acts as an air spring to hold a roll 36 on the arm 15 against a cam 34 fixed with relation to the arm 14. When air is admitted to the two cylinders to close the shears, the closing movement of the arm 15 is under the control of the cam 34. This cam is so shaped that the arm 15 is in its final closed position with the roll 36 on a concentric portion of the cam 34, just before the arm 14 completes its cutting stroke. In this way, the blade 10 completes its cutting stroke against the lower blade 11 which has come to rest at that time. When the arm 14 is moved to its open position by the air cylinder 26, the arm 15 is moved to open position by the action of the cam 34. Various adjustments are provided to secure proper operating position of the shear blades as is usual in shears of this general type.

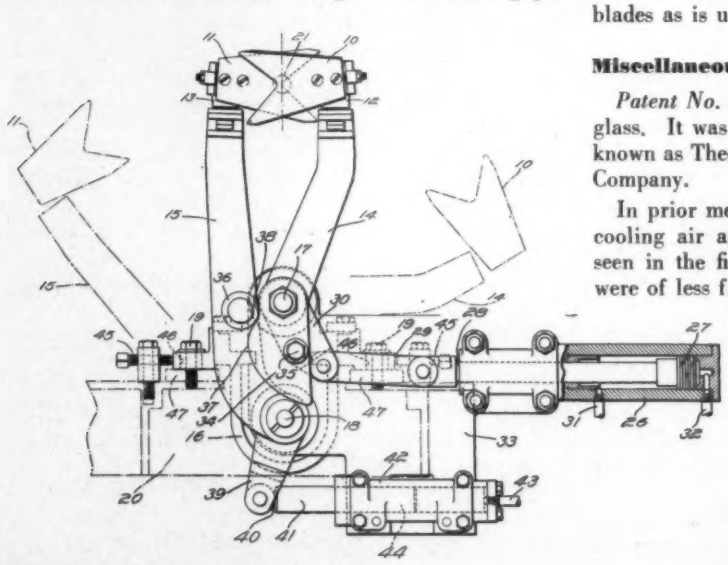


Fig. 1. Hartford-Empire Feeder Shears.

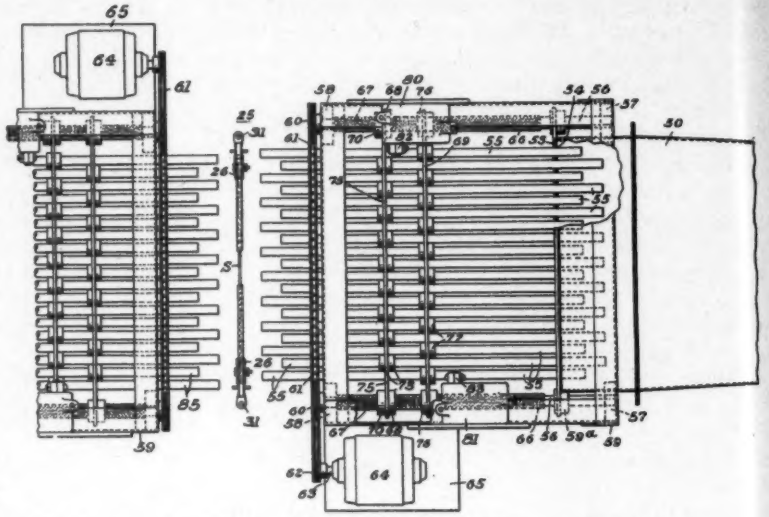


Fig. 2. American Window Glass Co., Method of Tempering Sheets.

Miscellaneous Processes

Patent No. 2,401,442 relates to the tempering of sheet glass. It was assigned by Theodore G. White (formerly known as Theodor G. Weihs) to American Window Glass Company.

In prior methods of tempering sheet glass by blowing cooling air against the hot sheets, iridescent spots are seen in the finished product. Such objectionable spots were of less frequent occurrence when the sheet was tempered by immersing it in a cooling liquid. However, the immersion process did not produce as high quality product in other respects.

This patent proposes to produce sheets of highest quality and without the objectionable iridescent spots by blowing a plurality of streams of air against the hot glass and periodically varying the intensity of the air jets. Preferably one set of jets increases in intensity while

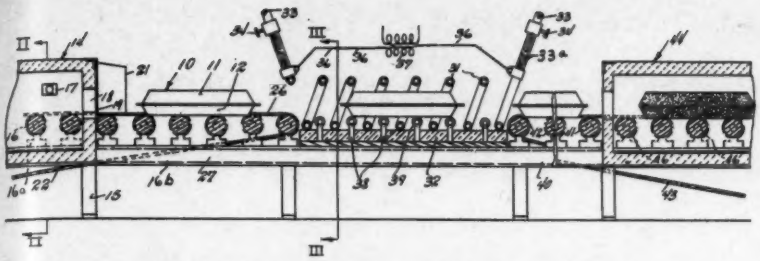


Fig. 3. Pittsburgh Plate Glass Process of Making Cellular Blocks.

the intensity of adjacent jets decreases.

Fig. 2 is a plan of the cooling part of the apparatus which is the essential feature of the invention. The glass sheet S is carried by a frame 25 having clamps 26. This frame slides on vertical guide rods 31. Above the cooling apparatus shown in the figure are two furnaces, one above the other. The frame 25 positions the sheet in the upper furnace where it is heated by electric elements to a temperature of about 900°. For a 3/16" sheet, this takes about 2½ minutes. The sheet is then lowered to the bottom furnace where it is brought up to nearly the softening point. It takes about the same time in this furnace to bring the glass up to about 1350° which has been found satisfactory. The sheet is then lowered into the cooling mechanism as shown in the figure.

This cooling mechanism is provided with air under pressure by a header 50, a similar one being provided on the other side of the sheet. The header is closed by a plate 53 having a series of holes 54 through which tubes or nozzles 55 are adapted to slide. A frame 59 supports four shafts 56 rotatable in bearings 57 and 58, there being a shaft near each corner of the header. Each shaft carries a sprocket 60 engaged by a chain 61 which is driven by a sprocket 62 mounted on the shaft 63 of a motor 64. The tubes 55 are arranged in two sets, one set being fixed in a plate 75 and the other set in a plate 69. The two plates and the tubes carried by each are reciprocated alternately in opposite directions by nuts 70 and 78 which engage threads 66 and 67 on the shafts 56. The nuts on one plate engage a left hand thread. Thus, while one set of tubes is advancing toward the sheet, the other set is moving away. The direction of rotation of the motor determines the direction of movement of the tubes.

The rotation of the motor is periodically reversed by limit switches 80 and 81 which are actuated by engagement by the plates 75 and 69. By this construction, the movement of the two sets of tubes toward and away from the sheet can be controlled. The tubes 85 on the opposite side are identical in construction and operation. Obviously, the tubes closest to the sheet produce a stronger air blast. As the tubes are continuously moving toward and from the sheet, the cooling effect of the air is constantly varying.

It has been found that best results are obtained when the tubes have a stroke of about 1⅝" and are about 1" from the glass at the closest approach. An air pressure of 6.6" of water is recommended. The rate of reciprocation of the tubes may be from 20 to 30 per minute but this can be varied as may be found desirable.

Patent No. 2,401,582 discloses a process of making cellular blocks and it was assigned by the inventor, William Owen, to Pittsburgh Plate Glass Company. The material of these blocks is pulverized glass and a gassing agent which liberates gas near the sintering temperature of the glass.

It has been usual to make such blocks from finely pulverized glass and a gassing agent such as calcium carbonate or carbon black. This produces a block having a volume several times that of the original material and having the desired characteristics, but difficulty has been encountered in providing cheap satisfactory molds. Also, it has been difficult to remove the blocks from the molds because the mold material contracts during cooling more than the blocks and, therefore, the blocks were firmly gripped in the mold, making removal difficult.

This invention overcomes this difficulty by making the molds of a material having good heat resistance and good electrical conductivity, such as nickel chromium steel. After the block has set sufficiently for removal, the molds are quickly heated which expands the molds sufficiently to release the blocks. The heating is preferably done by subjecting the molds to a high frequency field.

Fig. 3 shows a longitudinal section of an apparatus for carrying out this process. Molds 10 having upper parts 11 and lower parts 12 are made from a material having good refractory and electrical conductivity, such as chrome-nickel steel from 1/64" to 1/16" thick. The molds are first coated with a parting material, such as a slurry of hydrated bauxite or hydrated ferrous oxide. This is dried and the molds are charged with powdered glass to pass a screen from 100 to 200 mesh and about 1½ per cent of a gassing agent, such as precipitated calcium carbonate. The molds are filled to between 1/7 and 1/10 capacity. The charged molds pass through a furnace 14 at the left in the figure on conveyor rolls 16. Burners 17 heat the contents of the molds to the sintering temperature which may be around 1500 to 1600°F. This causes the material to fill the molds in the form of a bloated mass full of bubbles.

The molds then pass to a cooling platform 26 where the block is at least partially solidified. The molds are next rapidly reheated to expand them so that the blocks may be removed. This is done by a water cooled induction coil 31. This coil is connected by wires 36 with a high frequency generator 37 capable of attaining about 300,000 cycles per second. The generator should have sufficient power to heat the molds 200 or 300 degrees in 5 to 30 seconds.

The molds are moved quickly by hand to an unloading platform 40. Due to the rapid expansion of the block, the block may be easily removed and passed on by power driven rolls 46 to a lehr 44.

JESSOP NAMES DIRECTOR OF RESEARCH

It has recently been announced by Jessop Steel Company that J. L. Klein has been named Director of Research.

A graduate of Massachusetts Institute of Technology, Mr. Klein joined the company in 1943 as metallurgical research engineer and in 1944 became Head Research Metallurgist.

Research Digest

Practical Interpretations of Glass Technology

The Flow of Glass in Tank Furnaces

The "how, what and why" of what goes on inside of the glass furnace between the time the raw batch is introduced into the doghouse and the time its finished glass is delivered to the forming machine has long been a subject of much discussion, argumentation and experimentation. Of the several phases concerned, that which is of the most interest to the glass technologist is the "how" of the glass flow. The glass technologist is extremely interested in 1) how fast the molten glass (both that formed from the new batch and that formed from previous batches) flows; 2) the amount of glass in the furnace that actually flows into the feeder or revolving pot (or through the throat of the furnace); 3) the type of flow, i.e., whether it is streamlined or not; and 4) the location of stagnant areas and if and under what conditions such areas move.

Many different methods have been used to determine the answers to these questions. One of the most common of these methods has been the use of a floating, insoluble body whose progress in the furnace can be watched. This method, of course, measures only the surface conditions. Another method involves the use of a composition change by the introduction of a new ingredient in the glass followed by chemical analysis to show its presence and amount. In still another method, small amounts of highly colored glass is added to the batch. This method, while allowing the glass to be seen when it appears at the machine, usually spoils the glass for use. It is, therefore, used only when a furnace is about to go down.

Recently, two papers on glass flow have appeared in the literature, the first by F. L. Bishop, Jr. (*Journal of the American Ceramic Society*, November, 1945) deals with a variation of the chemical composition change and color change methods, while the second, by Vernon W. Lenz (*Journal of the American Ceramic Society*, January, 1946), is an improvement of the old color change method.

The process used and described by Bishop is similar to the old color change method except that the material added causes no visible change in the glass produced. The added material is detected by its fluorescence in ultraviolet light or by a change in ultraviolet absorption. In actual use, an amount of batch and cullet sufficient to charge for about one hour is mixed with about 0.3 per cent of cerium hydrate. The time of the start and finish of the charging of this batch are taken. Samples of the glass are then taken at regular intervals from various points in the melting and refining sections of the tank. (In the case of container glass furnaces, bottles may be taken from the forming machines at regular intervals.) These samples may be merely short rods drawn out on an iron tip; these are examined under filtered ultraviolet light, and the time (frequency) of arrival of the cerium-containing glass is noted. It should be noted that such measurements, while qualitative, can be quantitative by the use of a fluorimeter.

In Bishop's tests, made on a sheet glass furnace, samples were taken from the machines at different times before the addition of cerium. The light transmission in a narrow region around 325 mμ was determined for various glass thicknesses. The plotted curve was used as a standard. When the effect of the added cerium was felt at the machines, optical densities higher than this curve were obtained. Deviation-time data was then determined. Several kinds of information were obtained from the deviation-time curves for single machines. For example, the time of arrival of the cerium-containing glass at the various machines is shown by the significant variation. In one case, a significant deviation was shown for one machine at 2½ hours and for another machine at 4 hours. This is a measure of the average surface flow rates. By this method, the time for each machine on the tank was found, and it was found to be possible to tell which machines to watch for the first indications of any change in composition of the batch. Great differences were found between the various machines on a single tank, both in time of arrival and in the shape of the curve. Some machines received quickly large amounts of recently melted batch, while others showed much slower effects. An interesting feature of nearly all of the curves was the plurality of peaks, indicating that the flow of glass was occurring over more than one path.

Further treatment of these curves showed that 84 hours after the introduction of the cerium-containing batch, 50 per cent of the batch had become glass. In other words, of the glass being drawn at any time, 50 per cent had been in the tank less than 84 hours. The curves also show that of the glass being drawn at anytime, a small, but significant, portion, about 1 per cent, has been in the tank less than 12 hours. Bishop concludes that, because they are based on several assumptions, the figures that he gives are only approximate. They give, however, a relatively clear picture of the progress of the batch to the finished glass. He concludes that it is possible by combining the observations made on samples dipped from the tank at various times and the measurements made on finished products to determine both the rate of flow and the total amount of flow.

In the paper by Lenz, the flow was investigated in a direct-fired continuous melting tank furnace by the use of the conventional method of color addition, followed by "freezing" and "quarrying". The novelty was introduced by the use of color photography to record the "freezing in" of the color change. The coloring agent used was cobalt oxide; this was added as cobalt-blue glass cullet with the batch in an amount which gave 0.011 per cent of oxide in the total glass body. The cullet was added in two increments: the first, approximately thirty-two hours before the batch feeding was stopped, and, the second, just before the last batch was fed. The

(*Continued on page* 360)

McKEE GLASS ENTERS SUIT FOR $27,000,000

The McKee Glass Company of Jeannette, Pa., has brought a suit in the U. S. District Court of Pittsburgh against Hartford-Empire Company, Corning Glass Works and the Empire Machine Company. Many of the present or former officers of these companies are named as individual defendants.

The suit is based on charges under the Sherman anti-trust law similar to those made in the Toledo suit against the same companies.

The complaint states that McKee was licensed by Corning Glass Works to make heat resisting glassware and by Hartford-Empire Company to use its machinery. However, it is further stated that the Hartford license did not permit McKee to use Hartford equipment in the manufacture of heat reisisting ware which resulted in a monopoly by Corning to the extent of 95 per cent of all heat resisting ware produced.

The license to McKee expired in 1936 whereupon Corning cut its prices on this type of ware by 40 per cent forcing McKee to make the same cut. McKee claims that it lost $9,000,000 in profits due to the acts of these companies and it now asks that it be awarded triple damages and attorney's fees.

With regard to this latest court action involving Hartford-Empire, a spokesman for the company said that they had been advised as to the contents of the complaint, although it had not as yet been served on the company or any of its officers. It was the opinion of the company that the suit could be successfully defended.

It was further stated that this is one of a series of suits following the antitrust action in Toledo and brought by the same attorney representing other plaintiffs. The basis for the claim which the Hartford company regards as fantastic is that because McKee Glass Company made large profits during the war years they should have made similar profits for the fifteen years preceding the war.

NORTH A. WRIGHT DIES SUDDENLY

North A. Wright, Public Relations Director of Libbey-Owens-Ford Glass Company, died suddenly June 14. Mr. Wright succumbed to a heart attack at the age of 49.

Born in Atchison, Kansas, he attended the University of Kansas. Mr. Wright joined L-O-F in 1933, and, at the time of his death, was serving as Director of the Public Relations Department, having general direction of advertising, sales promotion, press relations and design departments.

During the recent war, Mr. Wright served as Director of the Producers' Council with headquarters in Washington, and was on liaison duty between L-O-F and various governmental agencies in expediting war materials and in developing new war products.

Surviving are his widow, Mrs. Marjorie Wright, and two sisters, Mrs. W. C. Oberlin and Mrs. G. K. Charles, both of Atchison.

• James F. Lynch, ceramic engineer, has been named to the staff of Battelle Institute and assigned to its division of ceramic research. Mr. Lynch is a graduate of New York State College of Ceramics and was recently discharged from the Army Air Forces.

W. D. DUGAN HEADS NEW GLASS COMPANY

The Neville Island Glass Company of Pittsburgh, Pa., has announced plans to begin construction of a glass factory to be located on Neville Island in the Ohio River. Production is expected to be 100 tons of glass per day and present plans are to concentrate on glass containers for the food industry and the pharmaceutical profession. A general line of glass containers, all made of flint glass, will also be manufactured. Production is expected to start in December of this year and 160 persons will be employed.

W. D. Dugan

Officers of the new company are W. D. Dugan, President and Director. Mr. Dugan was Secretary of Brockway Glass Company from 1927 until 1931 when he became associated with the Olean Glass Company as president and general manager. In 1935, when Olean was sold to Thatcher Manufacturing Company, he continued as president of Thatcher's Olean company until they were merged in 1942 when he became vice president in charge of production. Mr. Dugan was later transferred to the Elmira plant of Thatcher, remaining there until July 1945 when he organized and became president of the Neville Island Glass Company.

Ray Senkbeil, Vice President of the newly formed company, is a graduate mechanical engineer. He spent nine years with the Hartford-Empire Company, five years as production manager of the Maryland Glass Company and the last two years as production manager and assistant plant manager of the Olean plant of Thatcher Manufacturing Company.

Edward M. Westbrook, formerly office manager of Thatcher Manufacturing Company's Streator, Illinois, plant, is Treasurer, and Charles P. Franchot of New York City becomes Secretary and Director. Mr. Franchot is a member of the law firm of Franchot and Dessner, attorneys for the Neville Island Glass Co. W. D. Dessner, also a member of Franchot and Dessner, is Assistant Secretary of the new Neville firm.

Directors include Allan L. Melhado, New York City, a member of the New York Stock Exchange; Ralph C. Baker & Co.; Richard M. Marshall and T. W. Kirkpatrick, executive vice president and secretary, respectively, of the Pittsburgh Coke & Chemical Company.

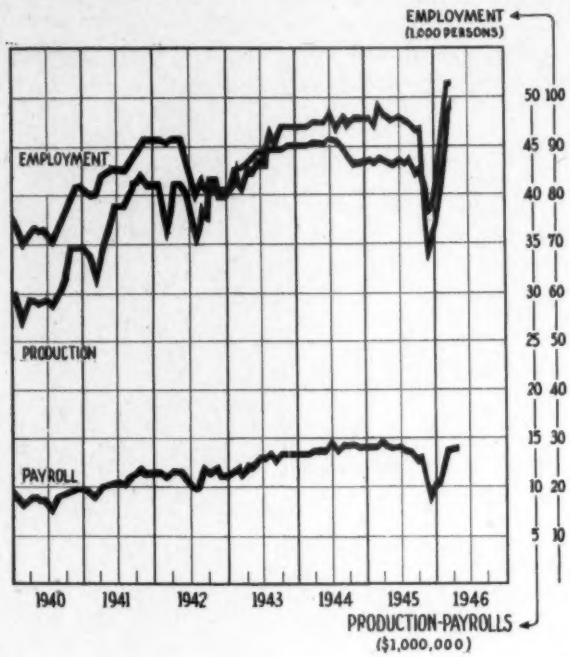
CORNING APPOINTS ADMINISTRATIVE ASSISTANT

Rushmore H. Mariner, formerly Assistant Manager of the Apparatus Department at Corning Glass Works, has been appointed Administrative Assistant to Dr. Jesse T. Littleton, the company's Director of Research. Mr. Mariner will handle administrative duties in the Laboratory Department and will study the commercial application of new developments in glass.

Following his graduation from Yale University, Mr. Mariner spent ten years in sales and administrative work.

CURRENT STATISTICAL POSITION OF GLASS

THE GLASS INDUSTRY'S INDEX



During April 1946, the Production Index indicated an estimated production of $50,000,000. This is about 1 per cent over the $49,500,000 reported for March. Production during April 1945 was estimated to be $48,000,000—about 4 per cent below the April figure for this year. Production during the first four months of 1946 has now reached an estimated total of $186,000,000, as compared with $191,000,000 for the same period in 1945.

Employment and payrolls: Employment during the month of April rose slightly to a little over 102,000 persons. During April 1945, only 87,000 persons were employed which is about 17 per cent below April this year.

Payrolls for April 1946 were an estimated $13,600,000, which is a little over the $13,500,000 reported for March. April 1945 payrolls were also estimated to be $13,500,000. Total payrolls for the first four months of 1946 are $40,700,500.

Glass container production for the month of May 1946, based on figures released by the Bureau of Census, indicated a slight decrease from the preceding month. Production has been steadily increasing since the first of the year, but has dropped off during April and May. May 1946 production was 8,960,660 gross, as compared with 9,529,645 gross produced during April. This indicates a drop from April of about 5 per cent. Production during May 1945 was reported to be 9,295,495 gross, which is about 3 per cent over May 1946. The January-May period shows a total production of 47,193,797 gross for 1946, in comparison with 42,158,446 gross produced during the corresponding period in 1945.

Shipments also dropped slightly during May. Reported shipments were 9,414,367 gross which is a little under the 9,660,542 gross shipped during April. Total shipments made thus far in 1946 total 47,714,040 gross as compared with 43,395,932 gross shipped during the same period in 1945.

Stocks on hand at the close of May 1946 are 3,642,641 gross. This is about 12 per cent under inventories at the end of April. Stocks on hand at the end of May 1945 were 4,443,620 gross.

Plate glass production for the month of May 1946 was reported by the Hughes Statistical Bureau to be 18,862,864 sq. ft. which is a little over the 18,514,580 sq. ft. for April. Production during May 1945 was 8,636,872 sq. ft. This indicates a difference of about 1.17 per cent between May last year and May this year. Total plate glass production thus far in 1946 is 74,874,478 sq. ft.,

(*Continued on page* 360)

GLASS CONTAINER PRODUCTION AND INVENTORY

(All figures in gross)

		Production May 1946	*Stocks May* 1946
Foods; Medicinal & Health Supplies; Chemicals, Household, Industrials; Toiletries & Cosmetics	Narrow Neck	3,086,055	1,652,143
	Wide Mouth	3,253,512	913,432
Dairy Products		331,894	156,451
Home Canning		275,823	308,068
Beverages, Returnable		509,721	295,288
Beverages, Non-returnable		.....	.....
Beer, Returnable		372,640	105,728
Beer, Non-returnable		37,942	15,230
Liquors		677,033	132,657
Wines		308,094	42,707
Packers' Tumblers		107,946	20,937
Total		8,960,660	3,642,641

GLASS CONTAINER SHIPMENTS

(All figures in gross)

Narrow Neck Containers	*May* 1946
Foods	812,112
Medicinal & Health Supplies	1,171,737
Chemical, Household, Industrials	610,831
Beverages, Returnable	558,140
Beverages, non-returnable	.....
Beer, Returnable	346,924
Beer, Non-returnable	42,462
Liquors	704,680
Wines	303,101
Toiletries & Cosmetics	537,601
Sub-Total (Narrow)	5,087,588
Wide Mouth Containers	
Foods	2,740,801
Dairy Products	314,729
Home Canning	344,993
Medicinal & Health Supplies	338,526
Chemical, Household, Industrials	116,224
Toiletries & Cosmetics	171,590
Packers' Tumblers	103,301
Sub-Total (Wide)	4,130,164
Total Domestic	9,217,752
Export Shipments	196,615
Total Shipments	9,414,367

More New Fluorine Compounds by General Chemical

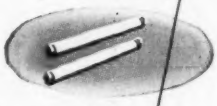
POTASSIUM
KF • HF
BIFLUORIDE

POTASSIUM
KF • 3HF
POLYACID
FLUORIDE

SOME POTENTIAL USES:

HEAT TREATING—Means of controlling the melting point of heat-treating salts.

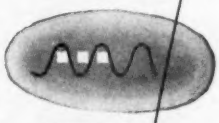
GLASS—In etching glass or other silicon-bearing products. As "frosting" agents.



CERAMICS—As opacifiers. As materials to increase the fluidity and alter the melting point of the mix.

CHEMICAL PROCESSING Source of HF in dry form. For preparation of elemental fluorine by electrolysis.

ELECTRONICS—Special medium for etching quartz crystals.



MINING—Agents for digestion of insoluble ores.

METALLURGY—As ingredients in fluxes and pastes for welding, brazing or soldering. For surface preparation of aluminum and stainless steel before spot welding.

General Chemical Fluorine Research announces Potassium Bifluoride and Potassium Polyacid Fluoride to American Industry. These are versatile, reactive products whose properties indicate varied applications. For example, consider their potentialities in the fields suggested here.

Perhaps such uses point to a place for either Potassium Bifluoride or Potassium Polyacid Fluoride in *your* development or production program. Experimental samples are available from General Chemical Company, Fluorine Division, 40 Rector Street, New York 6, N. Y., or through the nearest Sales and Technical Service Office.

When writing for the information you need, why not outline your proposed uses for these products? This way the technical experts of our Fluorine Division can work with you toward an early solution of your problem.

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FOR AMERICAN INDUSTRY

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In Wisconsin: General Chemical Wisconsin Corporation, Milwaukee, Wis.
In Canada: The Nichols Chemical Company, Limited Montreal • Toronto • Vancouver

NEW EQUIPMENT AND SUPPLIES

NEW TYPE-O THERMOSTAT

The United Electric Controls Company has announced a new Type-O thermostat of the remote-bulb type. It is specially designed for industrial applications requiring accurate control of temperatures over narrow calibrated ranges.

The thermostat can be used for all liquids or gases non-injurious to brass or for metal to metal applications and can be equipped with ambient temperature compensation. Thermal assemblies can be plated or supplied in stainless steel for applications injurious to brass.

Control is based on a snap-action switch actuated by a solidly liquid-filled copper thermal assembly. This assembly has an unvarying and rapid expansion and contraction per degree of temperature change and can be adjusted by either knob and pointer with calibrated dial, or by screw driver. The calibrated adjustments cover any 120° or 250°F. in the range from —120° to 600°F., and screw driver adjustments cover entire ranges from —120° to 180° F., from 50° to 350°, or from 50° to 600°F.

PENNSALT INTRODUCES TWO METAL CLEANERS

Pennsylvania Salt Manufacturing Company, Philadelphia 7, Pa., has started production on two new products, Pennsalt Cleaner A-22 for aluminum alloys and PM-95, an acid base cleaning and descaling compound.

Cleaner A-22 is a general purpose soak tank cleaner for use on all aluminum alloys. Most common applications are cleaning aluminum before anodizing, chromodizing, phosphatizing and other pre-painting treatment, and before deoxidizing and subsequent spot welding.

Pennsalt PM-95 is a specially prepared cleaning and descaling compound containing additional agents for surface action and inhibition. Suggested uses are general pickling and metal descaling, especially for difficult-to-remove oxides resulting from heat treating or annealing.

IMPROVED AIR GUN DEVELOPED

Algonquin Parts, Inc., 5000 Connecticut Avenue, South Norwalk, Conn., has announced the manufacture of "Guardair", an improved air gun. The patented design will not subject the operator to a blast of blinding particles that might prove fatal to vision, but, according to the report, contains an airguard located above the nozzle of the airgun providing a safety umbrella of air.

Particles ejected by the nozzle are instantly removed from the work by a feather-action thumb button. Instead of chips, metal powder, sawdust, etc., ricocheting into the operator's eyes, the particles are arrested by the invisible ring of air and plummeted downward.

Guardair is available with both standard nozzle, as well as with extended tip for deep hole drilling operations, etc. It is made in all standard, as well as special thread sizes to fit any hose coupling.

NEW FOLDING STEPS FOR TRUCKS

Safety Step Company, 1017 South LaBrea Avenue 35, Calif., is manufacturing quick-acting folding steps for motor trucks and trailers. These steps are engineered for use on flat racks, stake bodies, vans, trailers, and semi-trailers and are easily installed with four bolts.

Model R-16 is designed for installing on the rear of a truck. It may be mounted in the center or at either side. In close position, the steps are compactly folded under the truck bed. When the simple trip is manually operated, two sturdy 16-inch slip proof steps swing down and lock in open position ready for use. A slight lift and push on the bottom step swings and folds them back under the truck bed where they are automatically and securely locked in closed position out of the way.

Four bolts securely mount the step to the under side of the truck platform, requiring an average of about thirty minutes for the job. They are all metal and built to support a weight of 1,000 pounds. They weigh only forty pounds. The tread plates feature secure gripping action whether shoes are muddy, wet, icy, rubber clad or hobnailed.

LIGHTWEIGHT CONVEYOR ADDED TO TOTE-ALL LINE

Material Movement Industries, 310 S. Michigan Avenue, Chicago 4, Illinois, has added a lightweight portable conveyor to its line called the Tote-All Zephyr.

The 12 ft. model weighs only 135 pounds (without motor) and is made of special alloy steel. It is corrosion and abrasion resistant. At the present time, two lengths are available—12 ft. and 16 ft. Both models have an 8 inch belt. Power is furnished by a gasoline engine which is mounted above the conveyor. Engine mounting is adjustable to keep engine level at all conveyor positions.

"X-P" EXPENDABLE PALLET

Techtmann Industries, 714 West Wisconsin Avenue, Milwaukee 1, Wisconsin, is offering a new "X-P" Expendable Pallet which has been designed with an eye to shipping economy.

The new Pallet features a 60 per cent reduction in weight which is achieved by the use of a double corrugated board top supported on square or round wood blocks. Entire top and block ends are dipped in a water-resistant adhesive which seals off moisture from the load.

It is stated that 4,000-lb. loads have been carried on the "X-P" Pallet without failure. Maximum load stowage is attained in the standard 42x48 inch size since multiples of these dimensions nearly equal the widths of truck and box car bodies. Other sizes and double faced pallets are available with block spacings to suit users' lift equipment.

Over 1,300 empty pallets weighing approximately 30,000 lbs. can be nested in a 50-ft. box car using a lift truck for handling.

CATALOGUES RECEIVED

Brown Instrument Company, a division of Minneapolis-Honeywell Regulator Company, Philadelphia 44, Pa., has recently issue a Buyers' Guide on standard pyrometer supplies.

The booklet presents information to purchasing agents and instrument men on how to order thermocouples, protecting tubes, thermocouple wire, lead wire, insulators, etc. It contains complete description and prices on various types of standard thermocouples for applications in all industries.

The Meyercord Company, Chicago 4, Illinois, is distributing a new, full-color Decalcomania Sign "Ad-Visor", issued as a guide to point-of-sale promotion and containing suggestions for dealer identification and product promotion.

The brochure reproduces 94 decal signs used by leading advertisers, shows where, when and how to use decal store signs and suggests unusual designs and treatments. It illustrates how large expanses of free space may be utilized by decals.

Various steps in the Meyercord service to customers, from creative counsel to use testing, are described in pages which illustrate laboratory techniques, color photography, three-dimensional reproduction, merchandising counsel and advertising artistry available to users of decal programs.

Westinghouse Electric Company, Lamp Division, Bloomfield, New Jersey, has recently released a 24-page booklet explaining basic principles and operating characteristics of fluorescent lamps and auxiliaries.

The essential structure and operation of the mercury vapor electric discharge tube with its phosphor coating is shown diagrammatically and complete ratings are listed for important types of fluorescent lamps, including the instant start, slimline and circline.

Also explained, with the aid of sketches and diagrams, is the construction and function of ballasts, starters and lampholders.

MEYERCORD DECALS

offer the added sales-appealing

CHARM

that attracts more

CUSTOMERS

to your products—at low cost!

Attractively decorated merchandise produces more consumer sales volume . . . with greater profit to maker and dealer alike. Decorate with durable Meyercord Decals at a fraction of hand-painting time and cost. Manufacturers are invited to submit samples for expert decorating recommendations.

Executives: Send for this new Decal Decoration Catalog. (Firm letterheads, please)

Stock designs are available for immediate delivery. Exclusive designs can be produced to specifications on request. Address inquiries to Dept. 20-7

THE MEYERCORD CO.

World's Largest Decalcomania Manufacturers

5323 WEST LAKE STREET • • • CHICAGO 44, ILLINOIS

A. J. MONACK ESTABLISHES GLASS CONSULTING SERVICE

A. J. Monack, Rutherford, New Jersey, has resigned as engineering vice president and a member of the Board of Directors of the Mycalex Corporation of America in order to engage in consulting services on glass, glass-metal seals and general ceramic problems.

A former member of the staff of the Ceramic Engineering Department of the University of Illinois, Mr. Monack served with the Western Electric Company and the Radio Corporation of America prior to joining the staff of Mycalex Corporation in 1942.

Mr. Monack has written extensively on glass and insulation and has patented several types of hermetic seals and glass-bonded mica compositions.

COMMERCE DEPARTMENT ISSUES REPORT ON FUSED QUARTZ

Two German methods for making fused quartz are described in a 27-page report recently released by the Office of the Publication Board, Department of Commerce. The report was prepared by Malvern J. Gross for the Joint Intelligence Objectives Agency.

One of the methods, used by the W. C. Herraeus Platinschmelz, at Hanau, in making plates for angle mirrors for range finders, involved four steps: 1) selection and preparation of the quartz crystals, 2) manufacture of crude blocks of quartz glass, 3) forming and working of the crude blocks and 4) welding together of the plates.

Natural rock crystals from Brazil were the raw material. The crystals were prepared by removing visible foreign bodies and were then cracked by chilling and finally ground. Crude blocks were produced by sprinkling a continuous stream of fine crystal into a detonating gas flame on one end of a rotating quartz glass cylinder. The apparatus was designed so that the crystals would melt and build up in the cylinder. The resulting crude blocks were heated at a high temperature in an opaque tube and formed into rectangular blocks in dies. They were then ground and cut, ready for polishing. Welding of the plates to form angle mirrors was done in a crucible furnace.

The other method for producing fused quartz was observed at the Osram plant in Berlin. Brazilian quartz crystals were broken into pieces about the size of hazelnuts, melted in a furnace and drawn. According to the investigator, the process was not very satisfactory for drawing tubing more than 15 millimeters in diameter and furnace breakdowns occurred frequently.

• The Corning Glass Works' Board of Directors has received the resignation of Charles H. R. Young as assistant secretary and assistant treasurer. Mr. Young has been with the company for 29 years and is retiring because of ill health.

PROF. CARRUTHERS TO HEAD O.S.U. CERAMIC ENGINEERING

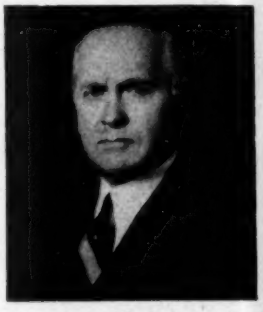
With the retirement of Professor Arthur S. Watts, Ohio State University has named Professor John L. Carruthers as Chairman of the Department of Ceramic Engineering. Professor Watts retires after 22 years' service to the University, 20 of which were spent as Chairman of the Department of Ceramic Engineering.

The new Chairman has served on the University's staff since 1925. He received his bachelor of ceramic engineering degree from Ohio State in 1921 and his professional ceramic engineering degree in 1934. He has been a member of the Student Council at the University and President of the student branch of the American Ceramic Society. Professor Carruthers has also served as President of the Institute of Ceramic Engineers and President of the American Ceramic Society.

EDWIN ALLEN RETIRES AS MATHIESON BOARD CHAIRMAN

It has recently been announced by The Mathieson Alkali Works that Edwin M. Allen has retired as Chairman of the Board of Directors. Mr. Allen will continue as a Director of the company.

Joining the company as President in 1919, Mr. Allen devoted himself to a plant rebuilding program which was needed after World War I. He formulated a plan for selling chemicals directly to users, then a radical departure from the established custom in the chemical industry, and organized traffic and technical service departments, in addition to extending the company's research and development facilities. In 1934, a new Mathieson plant started operations at Lake Charles.



Mr. Allen was elected Chairman of the Board of Directors in 1934 and held both this office and the Presidency until January 1, 1944 when he announced his retirement as President. However, he continued as Board Chairman until his present retirement.

PILKINGTON NAMES TECHNICAL WORKS MANAGER

Pilkington Glass Limited, a Canadian subsidiary of Pilkington Brothers, Ltd., England, has named R. G. Hunter as Technical Works Manager.

A graduate of Toronto and McGill Universities, Mr. Hunter joined Owens-Illinois Glass Company in 1931 as physicist and research engineer and was engaged in establishing a physics laboratory. In 1936, on behalf of Owens-Illinois, he became associated with Dr. F. W. Preston in the development of standard testing procedure for the glass container industry. In 1938, he undertook the development of improved technical control in the manufacture of glass blocks.

During the early part of the war, he returned to Canada and became associated with the development of the manufacture of optical glass at Research Enterprises Limited. He later became Director of Inspection and Control.

You associate sanitation with a grocery, and that's largely because of glass. Think of a market without glass showcases . . . glass containers for food products . . . glass bottles for liquids!

Many surprising new uses for glass are being developed, too. It is being used for draperies . . . awnings . . . insulation . . . fixtures and appliances for the modern home.

Essential to the manufacture of glass is *Soda Ash*. And a large part of the huge quantity of this valuable chemical used by the glass industry comes from Wyandotte Chemicals Corporation.

Wyandotte Soda Ash is also used in the making of pulp and paper . . . soap . . . non-ferrous metals . . . textiles . . . chemicals.

The result is a busy present—and the prospect of a busier future—in the production of Soda Ash at Wyandotte.

Wyandotte
REG. U. S. PAT. OFF.

OFFICES IN PRINCIPAL CITIES

WYANDOTTE CHEMICALS CORPORATION • WYANDOTTE, MICHIGAN

Soda Ash • Caustic Soda • Bicarbonate of Soda • Calcium Carbonate • Calcium Chloride • Chlorine Hydrogen • Sodium Zincates • Aromatic Intermediates • Dry Ice • Other Organic and Inorganic Chemicals

Attention . . .

Glass Tank Operators

For Maximum Life SPECIFY

C · S · R

CAST SUPER REFRACTORY

For

Mantels, Feeder Parts, Tuckstones, Burner Blocks, Port Covers, Port Bottoms, Port Arches, Port Skews, Port Baffles, Lintels, Jambs, Bridge-wall Covers, etc.

C.S.R. *has excellent resistance to*

HIGH TEMPERATURES

CORROSION

SHRINKAGE

SPALLING

C.S.R. *is*

VACUUM CAST

ACCURATE TO SIZE

UNIFORM TEXTURE

ECONOMICAL

●

Write for Full Particulars

WALSH REFRACTORIES CORP.

High Grade Refractories for Over 50 Years

4070 NORTH FIRST STREET ST. LOUIS 7, MISSOURI

CURRENT STATISTICS . . .

(*Continued from page* 354)

as compared with 43,399,990 sq. ft. produced during the corresponding period in 1945.

Automatic tumbler production for the month of May 1946 totalled 5,984,570 dozens. This figure indicates an approximate 13 per cent drop from the figure reported for April—6,935,081 dozens. Production during May 1945 was reported to be 6,325,218, which is about 5 per cent above the figure reported for May this year. Shipments during May 1946 reached a total of 6,712,081 dozens, or about 9 per cent below shipments for April which were 7,415,951 dozens. May 1945 was about 11 per cent below May 1946 and totalled 6,011,975 dozens. Stocks on hand at the end of May 1946 were 3,936,676 dozens, as compared with 4,410,267 dozens on hand at the end of April. In the compilation of these figures, one company had not yet reported its production, shipment or inventories. However, these figures were estimated for compilation in the above figures.

Table, kitchen and household glassware: Manufacturers' sales of machine-made table, kitchen and household glassware for the month of May 1946 increased approximately 10 per cent over April to reach a total of 4,512,616 dozens. April sales were 4,100,213 dozens. May 1945 sales were 2,755,331 dozens—or about 64 per cent below May of this year. Total sales during the 12-month period ending May 1946 were 42,042,927 dozens.

RESEARCH DIGEST . . .

(*Continued from page* 352)

time required for the first sign of color to appear at the discharge end of the tank was noted as an indication of the rate of "channeling" flow.

After the second addition, the batch feeder was stopped, the glass level dropped about 5 inches, the gas turned off and the furnace allowed to cool for three days. After the furnace was cool enough to enter, a visual inspection was first made. The back end of the furnace was then removed and the glass quarried out. The quarrying was done on parallel lines across the width and depth of the tank at approximately three-foot intervals along the length of the tank. Photographs, using 35 mm. Kodachrome film, were then taken in three separate positions across the face of each section.

From an analysis of the photographs and from other data, it was concluded that 1) the effects of operational changes (temperature, batch, etc.) in the melter of continuous tank furnaces can be detected in a time equivalent to one-twentieth of the calculated time required for one complete change of glass in the tank, 2) three primary, longitudinal convection spirals or channels exist in the glass body; these appear to extend through the entire depth of the glass body, and 3) very good mixing is obtained from the normal convection currents which exist in the tank during operation.

● R. G. Hunter has been appointed Technical Works Manager of Pilkington Glass, Ltd. of Toronto, a Canadian subsidiary of Pilkington Brothers, Ltd., England.

Through Passenger Service
Designed to Meet
INDUSTRY'S NEEDS

Here is a new passenger train service ideal for industrial executives making business trips between the East and West Coasts. This no-extra-fare service is 10 to 18 hours faster than previous service between Chicago-St. Louis and the West Coast terminals.

Between
NEW YORK-WASHINGTON, D. C. *and* LOS ANGELES-SAN FRANCISCO

• • • •

From New York . . . through sleeping-cars depart on the New York Central and the Pennsylvania railroads. On arrival at Chicago they are carried through to Los Angeles on the Transcontinental; to San Francisco on the Overland.

From Washington, D. C. . . . through sleeping-cars departing on the Pennsylvania are carried through from Chicago to Los Angeles on the Transcontinental—to San Francisco on the Pacific Limited. Departing on the Baltimore and Ohio, sleeping-cars are carried through to San Francisco on the Pacific Limited.

Similar service available eastbound from Los Angeles and San Francisco. No change of cars enroute in either direction.

Between
ST. LOUIS-KANSAS CITY-DENVER *and* PACIFIC COAST

• • • •

Departing from St. Louis on the new Streamliner "CITY OF ST. LOUIS" through sleeping-cars are routed to Portland-San Francisco and Los Angeles (via Kansas City-Denver) with no change of cars enroute. Similar service is available eastbound from the West Coast.

• • • •

For complete information regarding schedules, accommodations and other passenger service to or from the Union Pacific West, inquire at your local ticket office.

TO VACATIONISTS . . . Union Pacific serves more western scenic regions than any other railroad. These include California, Pacific Northwest, Colorado, Yellowstone and the National Parks of Southern Utah-Arizona.

be Specific – say "Union Pacific"

The Progressive

UNION PACIFIC RAILROAD

ROAD OF THE *Streamliners* AND THE *Challengers*

ISCO

POTASSIUM CARBONATE

Calcined 99/100%

Hydrated 83/85%

Manufactured by our

ISCO CHEMICAL DIVISION

NIAGARA FALLS, N. Y.

— and —

AMMONIUM CARBONATE

BEESWAX

CALCIUM CARBONATE

CHINA CLAY

FERRIC CHLORIDE

POTASSIUM BICHROMATE

SODIUM BICHROMATE

SODIUM SILICOFLUORIDE

SODIUM SULPHATE

TALC

•

Innis, Speiden & Co.

Industrial Chemicals since 1816

117 Liberty St. New York 6, N. Y.

Chicago Philadelphia Cleveland Cincinnati
Boston Gloversville, N. Y.

NEW APPOINTMENTS AT DIAMOND ALKALI

In a recent announcement concerning changes on the company's staff, Diamond Alkali Company made known

J. Cline McKenna E. A. Robinson

the appointment of J. Cline McKenna as manager of glass industry sales. Mr. McKenna succeeds George H. Dahlin, recently deceased.

Also announced was the appointment of Fred W. Fraley as Vice President-Sales. Mr. Fraley will assume additional management responsibilities.

W. H. McConnell has been named Director of Sales and J. D. Mattern as Assistant Director of Sales. Named as Technical Assistant to the Director of Sales is E. A. Robinson.

W. C. TAYLOR RECEIVES HONORARY DEGREE

The honorary degree of Doctor of Science was recently awarded William C. Taylor, Vice President and Director of Glass Technology of Corning Glass Works, for distinguished work in glass technology. The degree was conferred by Dr. J. E. Walters, President of Alfred University, and presented at the University's annual commencement exercises.

In his speech of presentation, Professor S. R. Scholes, head of Alfred University's glass technology department, reviews Mr. Taylor's career in glass. The co-inventor of the original Pyrex brand glasses, Mr. Taylor was cited for his many other developments in glass and for his scientific and technical publications in this field. He was the recipient of the Howard N. Potts Medal of Franklin Institute in 1928 and the Modern Pioneers of Industry award of the National Association of Manufacturers in 1940.

Mr. Taylor joined Corning Glass Works in 1908 and became Chief Chemist in 1920. He was made Director of Glass Technology in 1939.

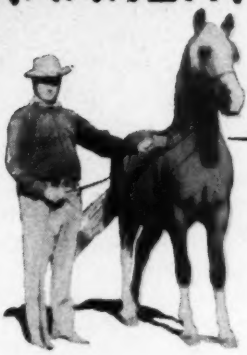
NEW PENNSALT PLANT UNDER CONSTRUCTION

Construction of a new $1,000,000 chemical plant by the Pennsylvania Salt Manufacturing Company of Washington has begun, according to a recent announcement. The new plant will be located on the Willamette River near Portland, Oregon.

According to company officials, operation is expected to begin about June 1, 1947.

These photos show a few of the 300 head of Palomino horses and colts on the Fisher Palomino Farm in Eastern Pennsylvania.

A TRUE PERMANENT COLOR



P. K. Fisher, President of the Pennsylvania Palomino Exhibitors Association, trying one of the color matching plates on Zephyr, his double registered Palomino Tennessee Walking Stalion.

AN UNUSUAL COLOR PROBLEM QUICKLY SOLVED BY HOMMEL

The Pennsylvania Palomino Exhibitors Association needed a set of plates that Association Directors could use in determining true color when registering a horse. All other plates tried either scratched, faded, or were not true to color. Porcelain enamel permanent color plates proved to be the answer.

Back of this quick solution was 55 years of color research and experience.

You too, can take advantage of this color "know how" and put an end to color production troubles. Hommel colors are made to perform well under your shop conditions. They are backed by Hommel's long reputation for quality. They are the result of continuous research in getting the best out of everything used in manufacturing ceramic colors—the result of successfully solving over tens of thousands of color problems.

Laboratory Controlled Production of Ceramic Supplies

O. HOMMEL CO.

PITTSBURGH 30, PENNA.

Pacific Coast Agents
L. H. BUTCHER CO.

- FRIT for Steel, Cast Iron or Pottery
- CERAMIC COLORS
- CHEMICALS
- BRONZE POWDERS
- METAL POWDERS
- SUPPLIES
- EQUIPMENT

Our Technical Staff and Samples are available to you without obligation. Let us help you with your problems.

ARMY E NAVY

World's Most Complete Ceramic Supplier

(*Continued from page* 348)

globular gas bubbles can be calculated[5]. Different electrical constants of powder glass, such as the electrical conductivity λ', the dielectirc constant ϵ' and the angle of loss, determined by tan δ', can be calculated from the corresponding values for the homogeneous glass (λ, ϵ, and tan δ). Thus if

$$p = \frac{\text{volume of all air bubbles}}{\text{total volume}},$$

we find that:

$$\frac{\lambda'}{\lambda} = \frac{2-2p}{2+p} \simeq 1 - \frac{3}{2}p + \ldots \quad (1)$$

$$\frac{\epsilon'}{\epsilon} = \frac{2\epsilon+1-2p\ (\epsilon-1)}{2\epsilon+1+p\ (\epsilon-1)},$$

which, e.g. when $\epsilon = 7$, gives

$$\frac{\epsilon'}{\epsilon} = \frac{5-4p}{5+2p} \simeq 1 - \frac{6}{5}p + \ldots \quad (2)$$

$$\frac{\tan\delta'}{\tan\delta} = \frac{2\ (5-3p)}{10-3\,p} \simeq 1 - \frac{3}{10}p + \ldots \quad (3)$$

The formulae are valid only when $p \ll 1$. In order to obtain an impression of the influence which the air bubbles have on the constants mentioned we substitute $p = 0.1$. Then $\lambda'/\lambda = 0.85$, $\epsilon'/\epsilon = 0.88$ and tg δ'/tg $\delta = 0.98$.

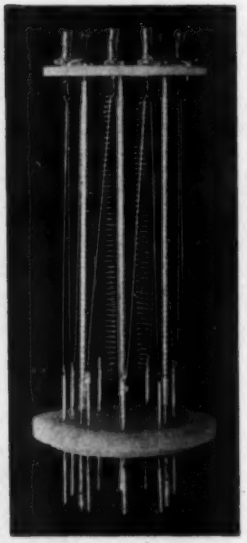


Fig. 6. Electrodes of a transmitting valve for short waves assembled directly on the powder-glass base.

A further lowering of the values of ϵ' and λ' can thus be obtained by distributing much air among many small bubbles. For this purpose it is necessary to start with very fine powder and during the fusion the temperature must be raised very rapidly to prevent the escape or flowing together of the air bubbles. By the addition of substances which give off gas the percentage can be very much increased, which, however, involves a lowering of the strength of the glass.

3) *Thermal properties.* The heat conduction in sintered glass shows almost the same variation with p as the electrical conductivity (see formula 1). The heat conductivity of powder glass is thus somewhat less than that of clear glass of the same composition. It is sometimes necessary to take special precautions in fusing because of this fact.

5. K. W. Wagner, Archiv für Elektrotechnik, 2, 382. 1914.

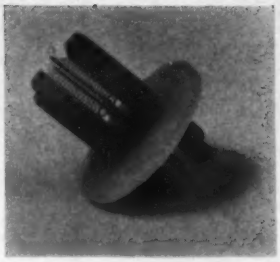


Fig. 7. Several transmitting valves for very short waves in which the electrodes themselves are fused into the base.

The coefficient of expansion of powder glass is the same as that of normal glass; the coefficient of expansion is not changed by the presence of air bubbles, which is a result of the well-known fact that a hollow body expands as if it were massive.

4) *Tensions.* Objects built up of more than one different material with different coefficients of expansion are not in general free of mechanical tensions at every temperature. This holds also for the welding together of two kinds of glass and for the introduction of a metal lead through glass. The occurrence of tensions in a glass object often leads to breakage and therefore methods have been developed for the checking of this. The tensions make the glass optically anisotropic and give rise to phenomena of double refraction, which can for instance be made visible with a polarization apparatus.

In this investigation of tensions it has now been found to the advantage of sintered glass that in objects manufactured with the help of this glass fewer mechanical tensions occur than in ordinary clear glass. This can be demonstrated by fusing together in pairs discs of different kinds of glass. When the discs fused together consist of powder glass smaller tensions appear after cooling than when the two discs are composed of the corresponding kinds of clear glass.

The explanation of this phenomenon is probably as follows: Since the solidification is accompanied by a decrease in volume, tensions will appear in the glass which are smaller the better the still soft glass is able to accommodate itself.

Now this is more easily possible in sintered glass than in clear glass of the same composition. If there is a large number of gas bubbles in the glass, as long as the surrounding glass is still somewhat soft they can compensate the volume decrease of the solidifying glass by expanding. This conception is thus based upon the fact that some parts of the piece of work become solid before the rest. This phenomenon often plays a part when metal components are fused in.

Completely homogeneous objects can also be made free of tension when normal glass is used by taking care that they are cooled very slowly. One of the advantages of sintered glass is that there is no objection to the cooling taking place more rapidly.

Applications

One of the chief applications of powder glass is in

(*Continued on page* 368)

Blanchardize! GRIND THEM

FASTER — MORE ACCURATELY — MORE ECONOMICALLY

Three years' experience in this field have produced these results:

(a) Former cost per piece, $7.25; Present cost per piece, 42 cents.

(b) Former time per piece, 75 minutes; Present time per piece 4 minutes.

(c) In five weeks, one Blanchard No. 11 has paid for itself.

Can you afford to be without a Blanchard?

BLANCHARD

The **BLANCHARD** MACHINE COMPANY

64 STATE STREET, CAMBRIDGE 39, MASS., U. S. A.

PROCESSING AND USE OF SELENIUM . . .

(*Continued from page* 349)

after being ground and screened, is retreated in the chain roaster at the silver refinery.

The retort bowls are heated in an oil-burning furnace at a temperature just sufficient to distil the selenium (1200° F.). Temperature is manually controlled with the aid of a thermocouple indicator set in the retort cover.

The retort distillate is collected in blocks which are allowed to cool slowly in order to obtain the grey metallic variety.

Metallic selenium is broken in a small jaw crusher and then pulverized in a pebble mill which is operated in closed circuit with an inclined vibrating screen. All 200 mesh is reground in a ball mill. Powdered selenium is packed and shipped in tins containing 5 lb. to 100 lb.

In addition to refined selenium, double distilled selenium, C.P. selenium, commercial selenium dioxide and C.P. selenium dioxide, sodium selenite and sodiun. selenate are also produced.

Selenium which has been refined by distillation is redistilled to obtain double distilled selenium. This is cast into flat cakes for cooling. This material is remelted in a stainless steel pot and poured through a specially-designed stainless steel shotter into distilled water. The double distilled selenium produced in this way is of the vitreous form.

Double distilled selenium cakes are the starting material from which special selenium products originate.

Selenium dioxide, SeO_2, is formed by oxidizing remelted double distilled selenium. Two grades are produced: C.P. SeO_2 is of guaranteed high quality; commercial SeO_2 is of somewhat lower purity. C.P. selenium dioxide is reduced in suitable equipment to form C.P. selenium which is sold in shotted form.

Sodium selenite is prepared by dissolving selenium dioxide in water to form selenious acid, neutralizing with soda ash, evaporating and crystallizing. Sodium selenate is made from selenic acid which is formed by the electrolytic oxidation of selenious acid. On neutralizing selenic acid with soda ash, sodium selenate is formed. This is recovered by evaporation and crystallization.

Typical analyses of selenium products are given in Table 2.

TABLE II

TYPICAL ANALYSES OF SELENIUM PLANT PRODUCTS

Material	*% Cu*	*% Te*	*% Fe*
Refined selenium	....	0.021	0.012
Double distilled selenium.....	....	0.013	0.002
Selenium dioxide	0.00002	0.0001	0.00011
C.P. selenium	0.00002	0.0001	0.00015

Selenium is a comparatively "new" element, its discovery dating back only some 130 years. It is widely distributed through the earth's crust, though in small amount, associated usually with copper-sulphide and gold ores. Up to the present, it has not found extensive commercial application and, as a consequence, its production has been relatively small. However, new uses are being steadily developed and its consumption is increasing.

World production of selenium approximates 1,400,000 pounds per year, with the United States and Canada as the principal sources. Canadian production in 1945 was 419,000 pounds and the highest was 495,000 in 1942. About 1,200 lbs. was consumed in Canada in 1944, compared with 4,200 lbs. consumed in 1941. The balance of Canadian production is exported, mostly to the United States with the United Kingdom in second place.

Selenium is added to glass to neutralize the green color caused by iron impurities. From 0.1 to 0.3 lb. selenium is added per ton of glass produced, depending upon the iron content of the charge. Excessive amounts of selenium tend to give the glass a pinkish tint. The dairy industry has turned this to advantage since the creamy appearance of milk is enhanced as seen in bottles so tinted.

The red color of ruby glass is obtained by adding gold, copper or selenium to the raw batch. Gold is, of course, expensive. Ruby glass made with copper tends to be dark when in thick plates and to lack the brilliance of selenium "ruby". Selenium, in conjunction with cadmium sulphide, yields a glass characterized by very good transmission in the red part of the spectrum with a short cut-off of other colors. For this reason, it is specified in railway, marine and other signal lenses.

Black glass for decorative purposes with light absorption characteristics superior to other commercial black glasses was developed several years ago at the Battelle Memorial Institute. This glass was made with addition of 0.6 per cent selenium and 0.1 per cent cobalt carbonate to the batch.

The glass industry consumes selenium mostly in the powdered form and to a much smaller extent as barium and sodium selenites.

CHEMISTS ELECT OFFICERS

At its annual meeting held recently, the Manufacturing Chemists Association of the United States elected officers and 15 executive committee members.

Charles S. Munson, chairman of the executive committee of U. S. Industrial Chemicals, Inc., was elected president. Mr. Munson succeeds H. L. Derby, president of the American Cyanamid and Chemical Corp. Leonard T. Beale, president of the Pennsylvania Salt Manufacturing Company, and H. O. C. Ingraham, vice president of the General Chemical Company, were elected vice presidents.

Named treasurer was J. W. McLaughlin, Carbide and Carbon Chemicals Corp., and Warren N. Watson, Washington, D. C., was re-elected secretary of the Association, which maintains its headquarters in Washington.

The Association elected the following executive committees: George W. Merck, president of Merck and Company, chairman; Lammot du Pont, chairman of E. I. du Pont de Nemours, vice chairman; Mr. Derby; C. S. Hosford, Jr., president of the Victor Chemical Works; John L. Smith, president of Charles Pfizer and Company, Inc.; Clyde D. Marlatt, vice president of the Martin Dennis Co.; W. S. Landes, vice president of the Celanese Corp. of America; P. T. Sharples, president of Sharples Chemicals, Inc.; H. I. Young, president of American Zinc, Lead and Smelting Company; and William M. Rand, president of Monsanto Chemical Company.

SURFACE TENSION OF GLASS . . .

(*Continued from page* 339)

measurements is plotted in Fig. 1 against the absolute values.

If T_A is the absolute value of surface tension and T_D the drop-weight value, the straight-line equation, $T_A = 1.86\ T_D$, fits the results with an average error of $\pm 3\%$ of the absolute values.

Since the glasses varied widely in chemical composition, the use of this equation should have general applicability for correcting drop-weight measurements of surface tension when an approximation to absolute values is desired.

FOOTNOTE REFERENCES

1. Tillotson: Industrial Engineering Chemistry, 3, 631 (1911). Tillotson: Industrial Engineering Chemistry, 4, 651 (1912).
2. The series of glasses is described in the Journal of American Ceramic Society, 20, 325 (1937), measurement of surface tension being made by the Jaeger maximum-bubble-pressure method.

EUROPEAN GLASS SITUATION REPORTED BY DR. BLAU AND CARL UHRMANN

Dr. Henry H. Blau and Carl J. Uhrmann, recently returned from Europe as investigators for the Technical Industrial Intelligence Branch, Department of Commerce, report that the European glass industry has developed a comprehensive system of grading, treating and selecting raw materials for use in glassmaking and has long engaged in intensive research on a cooperative basis.

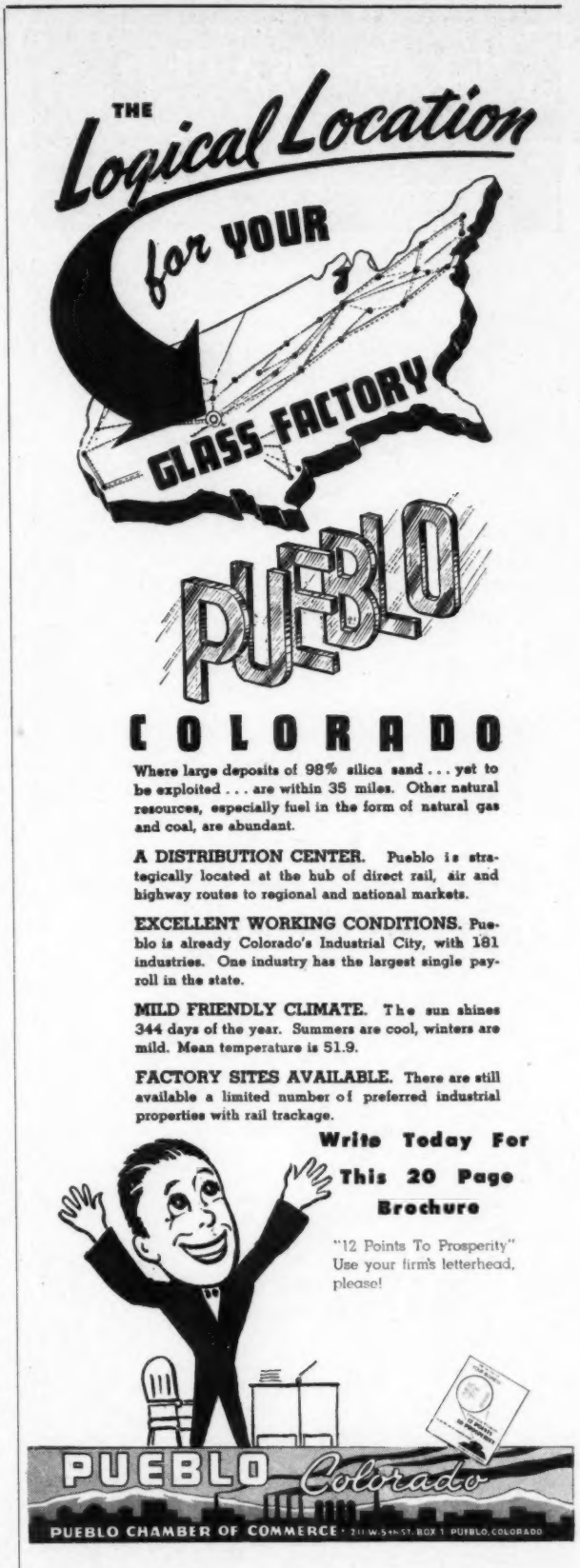
Dr. Blau, Vice-President in charge of production and research at the Federal Glass Company, and Mr. Urhmann, Vice-President of Imperial Glass Company, visited glass plants in Austria, Czechoslovakia, France, Germany and Switzerland. They reported their findings at a joint meeting of the American Glassware Association and the National Association of Manufacturers of Pressed and Blown Glassware in Pittsburgh.

By using silica sand, limestone and other raw materials made to exact specifications, European glassmakers are able to select the best ingredients for each type of glassware, the investigators stated. Adoption of similar specifications in America would permit increased production of high quality glassware, at lower prices than are now possible, in their opinion.

Despite emphasis on the quality of raw materials, the quality of European glass products has deteriorated since the beginning of the war, according to the report. Most European glassware now would not meet American standards. Under the Nazi regime, funds for improvements in the industry were drained off and recovery is slow.

Glassmakers in Europe have cooperated in fundamental and applied research to a much larger extent than in the United States, and two new institutes for glass research have been established recently in France and Czechoslovakia. Plans are being made for the founding of another in Germany. New labor-saving devices were found in use in some of the plants visited. European improvements in glass presses, grinding machinery and furnace design might be applied to advantage in America, the investigators said.

• The Gem Glass Company, Fairmount, Indiana, now has a third melting tank under construction. Only ruby colored glass will be made in this tank when completed.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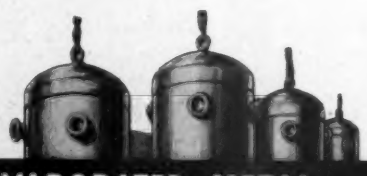

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SURFACE CHEMISTRY OF GLASS MOLDS . . .

(*Continued from page* 342)

Dierker[9] found that phosphated iron does not wet glass. It might be that the heavy phosphating of molds decreases the rate of oxidation. Occasional spraying of the molds and plungers with solutions of phosphoric acid or ammonium phosphate might have advantages.

According to Dierker[9], an oxide coating produced with any reducible gas (Bower-Barff process) wets the glass. It would seem then that steam used for cooling or cushioning purposes could promote sticking if the surface of the mold is not protected.

Some of the properties of gray-iron molds and castings[6] which favor their continued use are that they are easily machined, take on a high polish, are non-scaling and are probably protected to some extent by the numerous graphite flakes in the interior. But definite information regarding the value of surface treatments and the effects of different operational procedures can be obtained only if complete scientific records are kept and the data are obtained under the same or similar conditions as those found in glass houses.

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SINTERED GLASS . . .

(*Continued from page* 364)

lamps and tubes for experimental purposes. However, it also offers a number of advantages for other applications which in many cases are important. In the following we shall mention several of them.

1) *In tubes with complicated electrode systems.* As already mentioned, the glass can be introduced into the mould in the form of finely divided powder so that it can easily fill all the small cavities. Complicated pieces of work, such as lamp bases with very many leading-in wires or with leads very close to each other can be made of powder glass without much trouble (see Fig. 3). The freedom of choice in distance between the leads makes it possible to place them in such positions that the simplest and most logical assembly of the electrode system is achieved. Thus in Fig. 6 may be seen the grid-cathode part of a short-wave transmitting valve, in which the two electrodes are welded directly to the leads. These leads form two concentric circles with diameters corresponding to those of the cathode and grid. Such a construction excels in simplicity and sturdiness, while the slightness of the self-induction of the lead elements makes possible a satisfactory functioning on short waves. In extreme cases, in order to keep the self-induction as low as possible, it is possible to lead the electrode itself through the glass. Three examples are shown in Fig. 7 (see also Fig. 2).

In the left-hand valve there are two electrodes bent in a U-shape which pass through the glass base while retaining their cross section. The self-induction of the

lead part is very small here. At the same time good cooling is hereby obtained. In the case of the middle valve a shielding plate separating the two parts of the valve is led through the base.

The right-hand valve of Fig. 7 contains two leads in the form of strips which together form a Lecher system. Experience has shown that with clear glass and the ordinary pressing technique such constructions are only made reliable with difficulty. It is difficult to obtain a satisfactory distribution of the drops of glass. At the edges of the metal also the tensions are often too high, so that the valve cracks at that spot.

In the case of powder glass the first difficulty is non-existent, while less hindrance is experienced from the second.

2) *Crowded constructions.* Such constructions often result in high temperatures of the glass wall. It is then necessary to have recourse to glass with a high softening point. Normal boro-silicate glasses with a softening point of 500-600° C are often too soft or are too poor insulators at the high operating temperatures, so that harder glasses must be used. As a rule, these glasses cannot be pressed into narrow interstices in the ordinary way. Before the necessary pressure is reached the drop of glass has cooled off too far. The pressing in of metal parts directly is even more difficult. Due to the fact that pressing is unnecessary in powder technique, high requirements need not be made of the mould, and it can be heated to such a high temperature that even a very hard glass still becomes sufficiently fluid. It has hereby become possible to make lamp bases of kinds of glass, such as the so-called electrolysis-free glass, which could not formerly be so used and this again has opened the possibility of constructing new types of valves, especially in the field of transmitter valves for decimetre waves.

3) *Connecting seals.* It is possible to fill the mould with layers of powdered glass having different properties, and then to fuse the whole. By choosing powdered glasses of gradually increasing coefficients of expansion graded seals can be made, i.e., tubular parts which at one end can be fused to a glass with a high cofficient of expansion and at the other to a glass with a low coefficient of expansion.

Another possibility offered is that the base of a valve which is to contain the vapour of an alkali metal can be protected by a thin layer of resistant glass. It is well known that most kinds of glass are very severely attacked by such vapours. In the case of glasses containing lead, for example, such a strong reduction takes place that the glass turns black due to the liberated lead. Now by first scattering powdered lead glass in the mould and over it a thin layer of borate glass, a protecting layer is formed. Borate glass is not attacked; it cannot, however, be used alone, since the temperature interval in which softening takes place is particularly short. A variant on the foregoing is the use of glasses of different colour, by which means all kinds of indications can be introduced on the object.

4) *Rapid fusing-in and cooling.* Notwithstanding the fact that the conduction of heat in sintered glass is smaller than in the corresponding clear glass, it appears in heating that with sintered glass without many precautions a more equal heating through the whole object is

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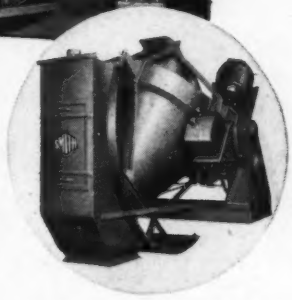

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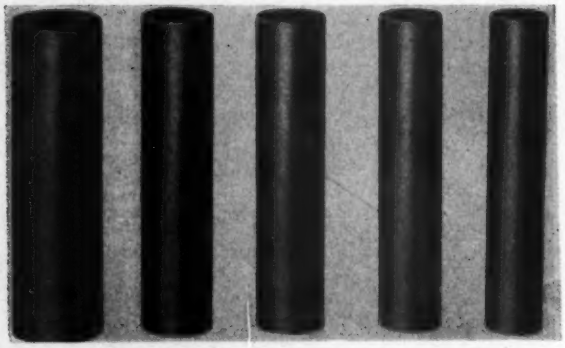

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obtained. Probably the numerous gas bubbles present in sintered glass ensure that during the heating the radiation of heat is strongly dissipated. One result of this is that the so-called pre-heating which precedes the fusing of a lamp base to the envelope can take place quite rapidly without cracking the tube. It is clear that this is of great importance in mass production. The annealing also can in most cases proceed quite rapidly due to the previously mentioned great elasticity of the still not completely solidified powder glass, so that the occurrence of large tension is combated.

SPEEDING UP GLASS MELTING . . .
(*Continued from page* 345)

In connection with this work of A. Dietzel, it might be worthwhile to mention another paper dealing with the sinter processes occurring in glass batches but from another point of view. K. Endell and M. von Ardenne followed the sintering of glass batches by means of an electron microscope. The instrument used was developed by M. von Ardenne and is described in the *Kolloid Zeitschr. 97* (1941) 257-272. It allowed the observation of high temperature processes with a 2500 x magnification. It is no doubt of interest to the research worker in the field of high temperature reactions to learn about this tool. In the particular case of batch reactions, however, the coarseness of the aggregates does not permit making full use of this powerful heating electron miscroscope. Besides the interesting pictures of sintering grains, the work has little to offer for the glass technologist.

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L-O-F REPORTS ON GLASS-PLASTIC TESTS

In a report made by Dr. G. B. Watkins and Dr. Joseph D. Ryan of Libbey-Owens-Ford Glass Company at the Golden Jubilee session of the Society of Automotive Engineers, it was shown that monolithic synthetic resin plastics recently developed and which resemble glass in transparency and rigidity cannot stand up to automotive glazing requirements for good vision, long wear, cleanliness and greater safety as does laminated safety glass.

In their study of "Automatic Glazing with Plastics", the scientists called attention to the vast changes which have been made in the quality and types of plastics since early automobiles were equipped with transparent, flexible pyroxylin plastic for back windows and side curtains.

Dr. Watkins, Director of Research at L-O-F, reported that actual trials were made in all kinds of weather and under many types of driving with sample glazings of plastics to be compared with safety glass.

Abrasion by dirt and action of the windshield wiper, for instance, on the plastic windshield made it almost impossible to drive towards the sun or headlights at night. Ice and snow did not melt on plastic windshields due to low thermal conductivity. From the standpoint of vision, a safety plate glass windshield was found to be superior after three to four years' service to the various plastic windshields after only a few weeks' service. Plastic windows did show up as more resistant to impact but when broken, they cracked into sharp, dagger-like particles, similar to ordinary glass.

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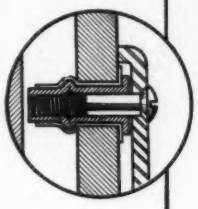

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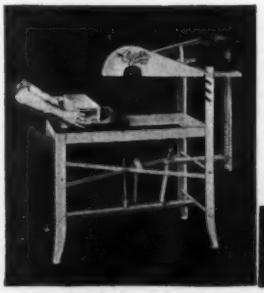

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